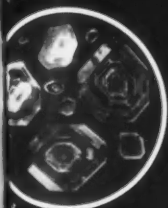
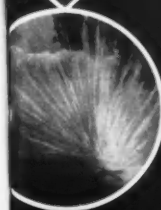


CHEMISTRY

DURHAM, N. C.
FEB 13 1959



FEBRUARY
1959



EIGHT PROJECT REPORTS IN 1959 TALENT SEARCH

Chemical Research Helped
Students Win Honors

	Page
Vitamin Deficiency	25
A Chemist Looks at Solar Energy	26
For the Home Lab	32
Drug Outclasses Morphine	33
Limit Right to Bear Children	34
Chemical Advance Against Insects	36
Chemistry Quiz	37
Chemical Specialties Manufacturers Association	38
Atomic Waste Problem	40
Power Plant to Play Space Role	43
"More" Uranium Than Ever	44
Alloy Resists Heat	44
Chemical Kills Water Weeds	45
Radiation Theory and Detection	45
Plastics Combine Metals	46
Book Condensations	47

CHEMISTRY DEPARTMENT LIBRARY

Editorial:

Student Projects in Chemistry
Inside Front Cover

50¢

Student Projects in Chemistry

➤ MANY MORE EXPERIMENTS are being undertaken in chemistry by students now than in former years due to increased interest in science fair exhibits and the sheer fun of experimenting.

Good teachers will agree that experimentation is the best way to science learning.

As an example of what others have done in science projects, CHEMISTRY in this issue publishes some of the scientific reports that helped high school seniors this year win honors in the Science Talent Search.

With a view to suggesting to students projects that may add to the world's store of knowledge as well as be interesting to do, Science Service asked representative scientists to suggest research for student-scientists. These were listed in the Science Clubs of American Sponsor Handbook. To further suggest chemistry projects, the chemistry section of this listing is reprinted in part below:

Make and try out solar evaporation stills, using the various plastic materials now available at the hardware stores. The most efficient configurations could be discovered by actual tests.

Test the corrosion resistance of reputed "stainless" articles that can be bought in the five and ten cent stores. In particular, for those that live near the ocean, the corrosion resistance to salt spray and outdoor atmosphere could be tested.

Investigate how bright summer sunlight causes the deterioration of ordinary plastics, paints, papers and other material. Some of these materials deteriorate so rapidly that visible effects can be determined in just a few days.

Experiment with chromatography, perhaps with the goal of detecting amino acids, etc.

CHEMISTRY

Vol. 32, No. 6

Formerly Chemistry Leaflet
Including The Science Leaflet

February, 1959

Published monthly, September through April, by Science Service, Inc., the non-profit institution for the popularization of science. Publication Office: 326 W. Beaver Ave., State College, Pa. Second class postage paid at State College, Pa., and at additional mailing offices. Address subscriptions and editorial communications to the Editorial Office: 1719 N Street N.W., Washington 6, D. C.

\$4 a Year; Two-Year Subscription \$7; Your Own and a Gift Subscription \$7 a Year.

50¢ a Copy. Ten or more subscriptions to the same address: \$2.90 a Year each.

No charge for Foreign or Canadian Postage.

Editor: WATSON DAVIS Assistant Editor: ELISABETH MITCHELL

Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

Editor in Memoriam: HELEN MILES DAVIS (1944-1957)

Copyright © 1959 by Science Service, Inc. All rights reserved. Science Service issues press service for newspapers and magazines, publishes Science News Letter (weekly), issues THINGS of Science (monthly) and administers Science Clubs of America.

Science Service is the educational and scientific institution organized in 1921 as a non-profit corporation with trustees nominated by the National Academy of Sciences, the National Research Council, the American Association for the Advancement of Science, the Scripps Estate and the Journalistic Profession.

Chemistry Projects

in the

1959 Science Talent Search

AMONG THE THOUSANDS of participants in the 18th Annual Science Talent Search, conducted by Science Clubs of America for the Westinghouse Science Scholarships, there were many students who expressed their intentions to become chemists. Many of the submitted projects — the high school scientist's equivalent of thesis research — demonstrated an advanced knowledge not only of the fundamentals of chemistry, but also of highly specialized and little publicized branches of the science as well as an informed grasp of those more and more frequent areas where it is difficult to differentiate chemistry from physics, biology, medicine and other sciences.

Of the 40 finalists 8 projects were in or closely related to chemistry. Among the 427 given honorable mention, 59 chose chemistry or biochemistry as their future career. Eight of the chemistry reports, some of them condensed in places, appear on the following pages. Three of them are winners.

	Page		Page
1. BIOCHEMISTRY OF VINEGAR	2	5. CRYSTAL ANALYSIS BY X-RAY DIFFRACTION	16
2. COOLING HOMES WITH SOLAR HEAT	6	6. SOLID INORGANIC ROCKET FUELS 19	
3. THE EFFICIENCY OF PAPER CHROMATOGRAPHIC SEPARATIONS OF INORGANIC MIXTURES 11		7. ISOLATION OF ORGANIC CHEMICAL COMPONENTS OF LICHENS ..	21
4. CHEMICAL SPECTROSCOPY	14	8. PAPER CHROMATOGRAPHY	23

The student or teacher interested in earlier reports in other fields will find many of them reprinted in the following Science Service Chemistry Series books, available at \$2.00 each, postpaid: Science Exhibits, Scientific Instruments You Can Make. A special issue of CHEMISTRY magazine with a 36-page section on SCIENCE TALENT SEARCH Project Reports is also available at a special price of \$.25 per copy. Order from Science Service, 1719 N St., N.W., Washington 6, D. C.

Biochemistry of Vinegar

by RONALD EUGENE GATES

Columbus High School, Marshfield, Wisconsin

Winner in the 18th Science Talent Search

► I UNDERTOOK vinegar-making as a project because of its biochemical aspect. It can be studied for both its enzymatic and bacterial reaction with a possibility of producing a large variety of acceptable vinegars. The possibility of vinegar varieties became an additional interest to me due to the increasing popularity in many Wisconsin areas of serving vinegar with special cheese menus.

The main methods used in the vinegar industry today are the Quick Vinegar Process and the much older Orleans Method. I used both methods with some modifications of my own, introduced because of the limited quantity of vinegar produced in each of my yields and also because of the kind of generating material I used. With the Orleans Method the yields were maintained at approximately one quart, but in the Quick Process the yields were reduced by one half mainly to increase the number of runs per day.

I made 22 different kinds of vinegar: six with the Quick Vinegar Process, (Table 1); fifteen with the Orleans Method modified, and one original variety from cattail roots according to a formula I arranged (Table 2). All vinegar samples in this project were obtained from the following substances either fresh or dried:

1. Fruits and vegetables:
 - a. Plums, elderberries, high bush

cranberry, grapes, apples (as cider), pineapple, sumac berries, beets;

- b. Carob pods with raisins and alcohol as well as plums and alcohol
2. Grain: malt
3. Flowers: dandelion flowers with oranges and lemons
4. Sugar: honey and brown sugar
5. Root: cattail rhizomes

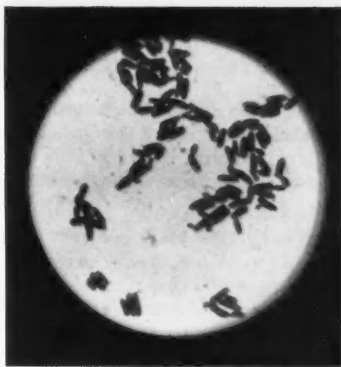
Since the Quick Vinegar Process depends on the circulation of an alcoholic feed during the time of its oxidation to acetic acid, I had to provide a suitable apparatus for it. Consequently, I built an all glass generator modeled after the glass experimental vinegar generators described in the *Vinegar News Letter* by F. M. Hildebrandt but with considerable innovations of my own. The body of my generator is a 20-inch hydrometer jar provided with two air vents near the base and a small drain opening at the bottom from where the run-off is delivered to a collecting vessel.

The feed charge is supplied at the top of the generator from an inverted bottle reservoir I was obliged to arrange here because my apparatus is manually operated. Provision is also made at the top for refluxing escaping alcohol vapors. Otherwise the upper end of the generator is air-tight. The feed charge is distributed and

controlled at a suitable rate with the aid of a two-pronged dripper I made and two perforated disks located in the cylinder above and below the packing of beechwood shavings which offer surface for the vinegar bacteria.

The six vinegars made with this generator followed similar procedures. A 500 c.c. mixture of nine parts ethanol and 91 parts of either diluted cider or fermented fruit juice (mild wine) previously prepared by the Orleans method and then strengthened with nutrients (Table 1), and autolyzed yeast was permitted to flow through the generator at the rate of about two runs per hour at nearly 29°C. Keeping this temperature necessitated preheating the charge for each run to 35°C. Because the generator was operated about eight hours each day, running time was extended to eight days instead of the usual five day limit in large scale productions. Checks showed that the allotted running time was sufficient for the bacterial oxidation of the alcohol. Yields from this process were clear and had an average nine per cent acid content, specific gravity from 1.01 to 1.02.

I was unable to follow the Orleans Method as it is usually practiced. So I reduced its rather laborious procedure to a few simple steps by which it was possible to prepare the generating material from crushed fruit, dissolved sugar and yeast in quantities small enough to be allowed to ferment in quart fruit jars over a period of six to eight weeks at 70-75° F. When it was evident that fermentation action was completed, vinegar bacteria was added as a starter for the acidification step. Clarifying of the mixture indicated when the acid conversion was finished, at which



➤ YEAST CELLS grown on the surface of grape juice. Photomicrograph taken three weeks after fermentation started. Stained with crystal violet. Staining indicates older cells.

point the filtered vinegar sample was pasteurized at 140°F. The length of time for both the fermentation and acidification varied from sample to sample. However, in spite of the fact that the Orleans method is slow, I obtained some of my most aromatic samples with it.

Eleven of the fifteen samples made with this method were made according to the above routine. The other four vinegar yields followed formulas only remotely resembling it. Vinegar can be a direct product of a chemical action occurring in two stages, first the yeast fermentation of sugar into alcohol and then bacterial oxidation of the alcohol into acetic acid and carbon dioxide. Literature also indicates that the two reactions may very often overlap. Because of the latter possibility, I tried making vinegar from an alcohol yeast combination in the same sugar solution to which I added carob

pods and raisins in one instance and carob pods and plums in the second case. Although these trials showed no visible signs of fermentation, the resulting vinegars, one a light yellow in color and the second a very pale pink, acquired what is regarded as a rich bouquet, a quality which includes taste, flavor, and odor.

In two other cases no yeast was used. In trial one, grapes were permitted to ferment on their own yeast (see photograph). In trial two, acetobacter xylinum was added to an alcohol-cider mixture and left to stand. In another instance only yeast and cider were used. The yeast was spread on the underside of a small float and placed on the surface of the liquid. Within eight weeks the three trials produced vinegar.

Malt vinegar was also made in a different way. The starch in the malt had to be saccharified with aid of the diastase in the grain. This was effected by keeping the malt mixture at 125°F. until the iodine test no longer showed blue. When this was attained, sugar was added and sudden chilling of the mixture followed. At this point fermentation was introduced with the addition of yeast and continued until vinegar bacteria was added six weeks later.

The preparation of my original variety of vinegar from cattail roots had a problem all its own. The attempted saccharifying of the starch in the rhizomes using the malt method showed that diastase, if present, was insufficient. I concluded that adding malt diastase would solve the problem. Therefore, about four ounces of malt extract saccharified at 125°F were added to the rhizome solution and

saccharifying was continued until the iodine test showed negative. From here on the procedure was the same as for malt vinegar, with this difference that the cattail extract took a longer time to ferment and acidify.

The last part of the project provided a series of interesting observations of the bacteria and enzymes occurring in vinegar-making. I observed that the acetobacter xylinum grown in the Orleans samples appeared similar to that taken from a pure culture of xylinum appearing as small thin rods occurring in groups. The shorter and somewhat thicker rod bacteria found in samples from both processes I identified as possible acetobacter pasteurianum. Bacteria from the top and bottom of the Quick Vinegar generator showed some difference in shape. Cultures made from the bacteria grown on the beechwood shavings of the generator were found to be non-motile and arranged in pairs or singly in large numbers. Their negative response to iodine staining identifies them with the acetobacter schützenbachii bacteria common to generators.

Although yeast does not continue growing when vinegar bacteria begins to multiply, I obtained photomicrographs of the two organisms in the same culture showing that this influence must be gradual. Yeast cells, when young, display distinct circular forms, but in their resting stage as they grow older, they may become more oval. Using Gram staining on these cells showed that the older cells took on the crystal violet stain while the younger cells favored carbol-fuchsin.

The most practical conclusion to be presented from this project is that

vinegar-making is a simple process, possible to be conducted in the home. Furthermore, vinegar may be prepared from the juices of most fruits thus

changing the flavor and aroma according to the fruit used. For entirely different vinegars one must use different bacteria.

TABLE I
VINEGARS MADE BY THE QUICK VINEGAR PROCESS

Generating Mixture		Nutrients	Running Time	No. of Runs	Average Temperature
CIDER VINEGAR					
500 cc cider vinegar (5% acid)	.1	gram di-ammonium phosphate	8 days	64	30 °C
500 cc cider stock (97.5 parts sweet cider and 2.5 parts 190 proof ethanol)	.65	gram malt syrup			
	.05	gram auto-lyzed yeast			
CIDER VINEGAR					
100 cc cider	.05	gram di-ammonium phosphate	7 days	53	30 °C
45 cc 190 proof ethanol		gram malt syrup			
2.8 cc ethyl acetate (85%)	.325	gram malt syrup			
352.2 cc water	.025	gram auto-lyzed yeast			
DANDELION VINEGAR					
478 cc dandelion wine	.5	gram di-ammonium phosphate	8 days	58	27.6°C
22 cc 190 proof ethanol	3.25	grams malt syrup			
	.25	gram auto-lyzed yeast			
ELDERBERRY VINEGAR					
489 cc elderberry wine	1	gram di-ammonium phosphate	8 days	50	28.3°C
11 cc 190 proof ethanol	6.5	grams malt syrup			
	.5	gram auto-lyzed yeast			
PLUM VINEGAR					
489 cc plum wine	.5	gram di-ammonium phosphate	8 days	56	29 °C
11 cc 190 proof ethanol	3.25	grams malt syrup			
	.25	gram auto-lyzed yeast			

CATTAIL VINEGAR

100 cc cattail wine	1	gram di-	8 days	57	29 °C
45 cc 190 proof ethanol		ammonium			
2.8 cc ethyl acetate	6.5	phosphate			
352.8 cc water		grams malt			
	.5	syrup			
		gram auto-			
		lyzed yeast			

TABLE II
VINEGAR MADE WITH THE ORLEANS METHOD

Vinegar	Color
Elderberry, fresh and dried	Deep red
Highbush cranberry	Cherry red, transparent
Sumac berries	Red brown
Pineapple flesh	Almost colorless, transparent
Pineapple rind and carob pods	Pale yellow orange, transparent
Apples (as sweet cider)	Light cider, transparent
Apples (as hard cider)	Dark cider, transparent
Plums, dried and carob pods	Faint red, transparent
Plums, fresh	Rich color of red
Grapes	Wine color
Raisins and Carob pods	Light cider, transparent
Beets	Deep red
Malt	Amber, transparent
Dandelion and citrus fruit	Light yellow orange, transparent
Brown sugar	Light cider, transparent
Cattail Rhizomes	Faint amber, very light

Cooling Homes with Solar Heat

by PAUL HAMPTON CORNEIL

Robert E. Lee High School, Baytown, Texas

Winner in the 18th Science Talent Search

➤ A POTENTIALLY important use of solar energy is the wintertime heating of homes. This, however, varies in efficiency with the availability of the sun, which is often not very intense during this season. For this reason, I became interested in the practicability of using the sun's energy during summer, the period of its greatest abundance, for the cooling of homes, a use similar to, but opposite from heat-

ing. The principal attractive feature of space cooling with solar energy is that when the greatest demand is on the system, the greatest amount of energy is available. This situation reduces or eliminates the need for energy storage required in the heating of homes.

The most feasible system to accomplish this purpose seems to be absorption refrigeration, the same as is used

in gas refrigerators to produce cold using heat. In this system, a refrigerant is boiled out of an absorber liquid by a heat source, condensed to a liquid, evaporated by a circulating light gas, thereby cooling the surrounding air, and dissolved out of the light gas back into the absorber liquid. For my work I selected the following materials to be used in a system at one atmosphere absolute pressure; normal pentane as the refrigerant, kerosene as the absorber liquid, and methane as the light gas because of its availability.

My first undertaking was to determine what would be required for a commercial 5-ton unit utilizing the above components. The kerosene and absorbed pentane are pumped to the solar heat collector, where the mixture is heated to about 175°F^* . At this temperature all the pentane is boiled out except that needed to preserve the one atmosphere vapor pressure of the mixture. In the separator, the pentane vapor bubbles out of solution and flows through the air-cooled condenser where it is liquefied. A fired heater under the separator supplements the sun's energy during cloudy periods and at night. The kerosene flows through a cooler so it may more easily reabsorb the pentane later. The liquid pentane, after flowing into a surge tank, maintains a constant level in the evaporator. This unit consists of parallel hollow fins connected at each end by a large manifold. In the evaporator the methane circulates over and evaporates the pentane, resulting in the absorption of heat. The heavy mixture of pentane vapor and methane sinks to the lower end of the ab-



► PAUL is shown here with his science display on cooling by solar heat.

sorber where the pentane is reabsorbed into the kerosene, and the methane, not dissolved, rises by gas displacement out the top of the absorber back into the evaporator. The pentane-kerosene mixture is pumped back to the solar heat collector.

For a typical 5-ton unit, 60,000 BTU/Hr. must be removed from the house air. The heat flow is shown in Table I. The pentane and methane entering the evaporator are at about 100° , and, desiring the temperature of the evaporator to be 55° to cool and dehumidify properly the air, we may calculate the necessary rate of flow of pentane. Pentane absorbs 158 BTU/Lb. when it is evaporated, but when it is cooled from 100° to 55° , it gives off 30 BTU/Lb. as indicated by its specific heat of 0.67 BTU/Lb. $^{\circ}\text{F}$. Also, the methane in being cooled the same amount gives off 7.8

* All temperatures are Fahrenheit.

BTU/ $\frac{1}{3}$ lb. (To preserve the one atmosphere pressure at 55° , 1.5 moles methane to each mole pentane, or $\frac{1}{3}$ lb. methane to each lb. pentane, are required.) Thus, in the passing of 1 lb. pentane and $\frac{1}{3}$ lb. methane through the evaporator, a net of 120.2 BTU is absorbed from the air, and for the removal of 60,000 BTU/Hr., 500 Lb./Hr. pentane are required with 167 Lb./Hr. methane.

Working from this, we may now calculate the flow rate of kerosene. The heat of absorption of pentane vapor in the kerosene raises the temperature of the pentane-kerosene mixture leaving the absorber to about 125° . At this temperature the vapor pressure of pentane is 1.65 atmospheres. That of the kerosene is negligible, and, consequently, the one atmosphere vapor pressure of the mixture is due entirely to whatever pentane is dissolved in it. The mole fraction dissolved times the vapor pressure at 125° must equal the one atmosphere pressure maintained throughout the system, and the mole fraction thus equals $1.00/1.65$, or 0.607. Let x be the moles/hr. of kerosene, $0.111x$ be the moles/hr. pentane dissolved in incoming kerosene (0.1 mole fraction not boiled out at 260° in the separator, preserving one atmosphere pressure there), and 6.94 be the moles/hr. pentane (500 Lb./Hr.). The 0.607 mole fraction then equals

$$\frac{0.111x + 6.94}{x + 0.111x + 6.94}$$

and x is 4.82 moles/hr. = 866 Lb./Hr. kerosene.

The kerosene-pentane mixture entering the heat collector from the absorber is at 125° . It is to be raised to

approximately 175° , a temperature attainable with the conventional flat-plate water-heating heat collector. The pentane is to be vaporized in the heat collector at 400 Lb./Hr. (determined from mole fraction remaining in solution at 175°). To accomplish this, 101,200 BTU/Hr. must be absorbed by the solar heat collector. At a solar incidence of 500 cal./cm²/day, an average figure, a collector performing at 175° will absorb 800 BTU/Ft.²/500 min. day, or 96 BTU/Ft.²/Hr. Thus, a 1054 Ft.² collector is required, but this figure can be varied according to actual average solar radiation, efficiency of collection, daily demand on the system, etc.

The kerosene entering the fired heater carries 138 Lb./Hr., 0.286 mole fraction, dissolved pentane. At 260° in the heater, all but 0.1 mole fraction of the solution is kerosene, 100 Lb./Hr. pentane being vaporized in addition to that vaporized in the solar heater. The input to the fired heater comes to 64,600 BTU/Hr.

On the market now is a commercial air-conditioning unit based on absorption refrigeration, using a gas flame as the sole heat source. This unit requires about 2.00 BTU heat input for each BTU of cooling accomplished. In my solar air-conditioning unit, we must buy only that amount of heat put into the fired heater under the separator. This is 1.075 BTU purchased for each BTU removed from the house — a decided saving.

I selected the materials used so the system would operate under one atmosphere pressure for two reasons: the calculations determining the liquid-gas relationships and heat flow

would be simplified, and a working model, which I had planned from the outset to build, would be easier to work with. The model was my next endeavor.

Since the methane circulation depends entirely on gravity, an important factor in the design of the model was to obtain a column of sufficient height so that the difference in vapor densities could circulate the gas. The treatment of the solar heat collector, evaporator, and absorber was also a problem. In the final design, the heat collector consisted of a series of blackened $\frac{3}{8}$ inch copper tubes connected at each end by a $\frac{1}{2}$ inch tube. The evaporator was a single hollow metal fin, one inch lower at the input end than at the exit end to make the pentane level shallower at the exit end and to allow free circulation of pentane vapor and methane. The absorber was a 3 inch glass tube, $2\frac{1}{2}$ feet high, provided with a methane exit at the top connected to the input of the evaporator. A 1 inch copper tube conducted the methane-pentane vapor mixture directly from the exit end of the evaporator to the bottom of the absorber. Construction of the other components posed no unusual problems. All connecting tubing and cooling coils were $\frac{1}{4}$ inch and $\frac{3}{8}$ inch copper tubing. The surge tank and separator were glass pieces of 1 inch and 2 inch diameters, respectively, provided with stoppers for the introduction of liquids. Heat sources were an infrared lamp (sun) and a Bunsen burner (fired heater). One pump was necessary to lift the kerosene-pentane mixture up to the heat collector from the absorber, and valves were provided just after the

pump and on the kerosene stream just before the absorber to control liquid flow. Packing was provided in the absorber to distribute the kerosene.

To initiate operation of the model, all air in the system was displaced by methane by allowing natural gas to flow through for 20 to 30 minutes, and the system was then closed off. Kerosene was poured in the top of the separator until it reached a level of two inches in the absorber and simultaneously half filled the separator while the pump was running. The kerosene was circulated while the valves were adjusted for even flow. When the circulation became even, I introduced the pentane into the top of the surge tank, filled the evaporator (the temperature of which immediately began to drop), and formed a rich solution of pentane in the kerosene. By experiment I found about equal volumes of kerosene and pentane (nearly one quart each) produced the desired results.

During the period while only kerosene was flowing through the system, the heat lamp was turned on to warm the heat collector. Under normal circumstances I found that the lamp was sufficient, and the Bunsen burner was not used. Using methane as the light gas, I obtained temperatures in the evaporator of several degrees below room temperature; but in operations conducted where natural gas was not available, I found that air, heavier than methane, but still lighter than pentane vapor, would work, but the temperatures obtained were not so low since the air circulation was slower than that for methane.

In my work I have designed a solar

air-cooling system based on the fact that the maximum available solar energy coincides with the maximum demand on the system. I have collected this energy at the highest efficient temperature obtainable with the ordinary flat-plate collector, supplemented by a gas-fired heater when neces-

sary. The solar air-conditioner is shown to economize on the amount of purchased energy required, and in my opinion, it should prove to be an attractive means of utilizing solar energy, especially in the parts of the world where energy costs are high and solar heat is plentiful.

TABLE I
HEAT FLOW, BTU/HOUR

INPUT FROM:

Solar Heater

1. Heat 866 lb. kerosene 125° to 175°
 $866 \text{ X } (175 - 125) \text{ X } 0.55 \text{ (sp. heat, BTU/Lb./°F.)} = 23,800$
2. Heat 538 lb. pentane 125° to 175°
 $538 \text{ X } (175 - 125) \text{ X } 0.71 \text{ (sp. heat, BTU/Lb./°F.)} = 19,000$
3. Vaporize 400 lb. pentane
 $400 \text{ X } 146 \text{ (latent heat of vaporization, BTU/Lb.)} = 58,200$

Total	101,000	101,000
-------------	---------	---------

Fired Heater

1. Heat 866 lb. kerosene 175° to 260°
 $866 \text{ X } (260 - 175) \text{ X } 0.58 \text{ (sp. heat, 175°-260° range)} = 42,200$
2. Heat 138 lb. pentane 175° to 260°
 $138 \text{ X } (260 - 175) \text{ X } 0.76 \text{ (sp. heat, 175°-260° range)} = 8,600$
3. Vaporize 100 lb. pentane
 $100 \text{ X } 130 \text{ (heat of vaporization, 175°-260° range)} = 13,000$

Total	64,000	64,000
-------------	--------	--------

House

- | | | |
|-----------------------------|--------|--------|
| 1. 5 tons air-cooling | 60,000 | 60,000 |
|-----------------------------|--------|--------|

GRAND TOTAL	225,000	
-------------------	---------	--

OUTPUT FROM:

Kerosene Cooler

1. Cool 866 lb. kerosene 260° to 100°
 $866 \text{ X } (260 - 175) \text{ X } 0.58 + 866 \text{ X } (175 - 100) \text{ X } 0.55 = 78,500$
2. Cool 38 lb. pentane 260° to 100°
 $38 \text{ X } (260 - 175) \text{ X } 0.76 + 38 \text{ X } (175 - 100) \text{ X } 0.71 = 4,500$

Total	83,000	83,000
-------------	--------	--------

Pentane Condenser

1. Cool 500 lb. pentane gas, 400 lb. 175° to 100°,
 100 lb. 260° to 100°
 $400 \text{ X } (175 - 100) \text{ X } 0.43 \text{ (BTU/Lb./°F.)} = 13,200$
 $100 \text{ X } (260 - 175) \text{ X } 0.48 \text{ (BTU/Lb./°F.)} = 4,200$
 $100 \text{ X } (175 - 100) \text{ X } 0.43 \text{ (BTU/Lb./°F.)} = 3,600$

	21,000	
--	--------	--

2. Condense 500 lb. pentane @ 100°		
500 X 158 (latent heat of condensation, 100°)	=	79,000
Total		100,000
Absorber		
1. Heat 866 lb. kerosene 100° to 125°		
866 X (125 - 100) X 0.55 (sp. heat)	=	11,900
2. Heat 167 lb. methane 55° to 100°		
167 X (100 - 55) X 0.54 (sp. heat)	=	4,050
3. Heat 500 lb. pentane gas 55° to 125°		
500 X (125 - 100) X 0.43 (sp. heat)	=	5,380
500 X (100 - 55) X 0.40 (sp. heat)	=	9,000
4. Heat 38 lb. pentane liquid to 100° to 125°		
38 X (125 - 100) X 0.71	=	670
Total Heat Required		31,000
5. Condense 500 lb. pentane		
500 X 146 (heat of condensation)	=	73,000
Total Heat Available		73,000
		73,000
		- 31,000
Net Heat to Atmosphere		42,000
GRAND TOTAL		225,000

The Efficiency of Paper Chromatographic Separations of Inorganic Mixtures

by HAROLD THOMAS PETERSON, JR.

Elmont Memorial High School, Elmont N.Y.

Winner in the 18th Science Talent Search

► PAPER CHROMATOGRAPHY is a method of chemical separation in which the components of a mixture are separated because of their different rates of absorption between a moving solvent and a paper strip.

A small volume of material (usually about ten microliters or lambdas) is applied to the paper using a micro-pipette. This spot is allowed to dry and then the paper is placed in a chemical solvent so that only the end

of the paper below the sample spot is in contact with the solvent. The solvent rises by capillary action carrying with it certain components of the mixture. As the solvent carries the components upward they are absorbed on the paper and reabsorbed from the paper into the solvent. The different rates of absorption between the paper and the solvent depend upon the chemical properties of the groups being separated.

After the solvent has risen to a height of twenty centimeters (most separations will occur within this length) the paper is removed from the solvent, allowed to dry and treated with chemical indicators to reveal the location of the separated zones. Physical methods such as conductivity and density measurement can also be used to determine the separated zone locations.

Paper chromatography has been used extensively in recent years for the separation of both organic and inorganic mixtures but very little work has been done on the theoretical mechanism causing the separations. I am trying to develop a series of mathematical relationships that will predict the separation distances between adjacent metals. This will determine whether a proposed separation would be successful.

Variations of Solvent Rise with Time

The height to which the solvent rises is a function of the time, the physical properties of the solvent (density, surface tension, and viscosity), and the physical properties of the paper (density, thickness, and method of manufacture).

Müller and Clegg (*Analytical Chemistry*, v. 23, p. 408, 1951) have developed two equations for determining the height of solvent rise with time. They are $h^2 = Dt - \beta$, and $D = \frac{\alpha\mu}{\eta} d + \beta$.

h = the height of solvent rise (in millimeters)

D = the diffusion constant, a function of the paper and the solvent used

β = a constant dependent on the paper used

α = another constant dependent on the paper

μ = the surface tension of the solvent (dynes/cm)

d = the density of the solvent (gm/ml)

η = the viscosity of the solvent (centipoises)

The viscosity, surface tension, and density of the solvent are dependent upon the temperature hence the rate of solvent rise is a function of the temperature of the solvent.

In their work, Müller and Clegg determined the constants for three papers: Schleicher & Schuell no. 601, no. 598, and no. 589 white. My investigations extend their equations to determine the constants for two other papers: Whatman no. 3MM and Eaton-Dikeman no. 613.

I determined constants α and β by substituting known values for the solvent variables of water at twenty degrees centigrade and measured the height of the solvent rise during set periods of time. These results were substituted in Müller and Clegg's equations to derive the constants. I measured the rate of solvent rise by graduating one-inch strips of paper with a metric scale. The papers were then placed in the solvent (water) and readings were taken every thirty seconds for Eaton-Dikeman no. 613 and every fifteen seconds for Whatman no. 3MM. A light was placed behind the paper to reveal the solvent front, the wet paper being more translucent than the dry part of the strip. Tables I and II show the readings.

The following results were obtained: for Whatman no. 3MM: the α constant was slightly larger than 65, the β constant was -139, and the

diffusion constant was 389. For Eaton-Dikeman no. 613 the α constant was slightly larger than 71, the β constant was -144 and the diffusion constant was 432.

The results obtained from these

readings are suitable for determining the height of solvent rise below ten minutes time. Above this level the effect of gravity decreases the solvent rise and corrections must be made to account for this action.

TABLE I
EATON DIKEMAN # 613

Time in Minutes	Height of Solvent Rise in Millimeters						
	Run 1	Number 2	3	4	5	6	h^{-2}
0.5	18	18	18	18	18	18	324
1.0	24	24	24	24	24	24	576
1.5	28	29	29	28	28	28	784 +
2.0	32	32	33	32	32	32	1024
2.5	35	35	—	35	35	35	1225
3.0	38	38	39	39	38	39	1482.3
3.5	41	41	41	41	41	41	1681
4.0	43	43	—	43	43	43	1849
4.5	45	45	—	45	45	45	2025
5.0	47	48	—	48	48	48	2304
5.5	50	50	—	51	50	50	2500
6.0	52	52	53	52	52	52	2704
6.5	54	54	55	54	54	54	2916

TABLE II
WHATMAN 3MM

Time in Minutes	Height of Solvent Rise in Millimeters				
	Run Number	1	2	3	4
0.25	15	—	15	14	219
0.50	—	17	18	—	310
0.75	20	20	20.5	21	416
1.00	22.5	22.3	23	23	515
1.25	25	25	—	25	625
1.50	—	—	—	27	729
1.75	—	—	—	—	—
2.00	30	—	—	30	900

— Indicates no reading taken.

Spot Size of Applied Sample

In the course of the determination of the solvent rise constants, I discovered that the spots applied to the paper varied directly in size with the sample volume. I prepared a ferric chloride solution and applied 1, 3, 5, and 10 lambda samples to the Whatman 3MM and Eaton-Dikeman 613 papers. I computed the areas of the spots formed after treating them with potassium ferrocyanide to reveal their location by the formation of a blue iron compound.

TABLE III

SPOT SIZE vs. VOLUME

Volume (λ) (Spot Area) $\times (\pi/4)$

	Whatman 3MM	E-D 613
1	16	41
3	49	96
5	81	153
10	100	289

These results were graphed and gave two straight lines. The slopes of these lines were determined and in-

tegrated giving the equations of the lines in terms of the spot area and applied volume. These equations are $d = 4\sqrt{v}$, $A = 4\pi v$ for Whatman 3MM and $d = \sqrt{27v} + 3.6$, $A = (108 v + 51.2)/\pi$ for Eaton-Dikeman 613, where the spot diameter is represented by d , the spot area by A , and the volume by v . The volume is in lambdas, the area in square millimeters and the diameter in millimeters. In some cases the spots are not circular but the maximum difference between the two diameters taken at right angles in these cases does exceed two millimeters.

Plans for Future Work

In order to develop the mathematical relationships necessary to predict the separational distances several other factors still needs investigation. I intend to investigate the effect of spot movement upon spot size, the differences in spot size with differing concentrations of the sample, and some of the chemical relationships that cause the separations.

Chemical Spectroscopy

by JAMES HARLOWE WILMOTTE

Arlington High School, Arlington Heights, Ill.

Given Honors in the 18th Science Talent Search

► NINE MONTHS AGO I knew nothing about spectra, spectroscopy, or the continuous spectrum of visible light. One day during a physics experiment, the group that I was working with was assigned an experiment dealing with a spectroscope. When my teacher explained the scientific principle of the grating used, I was amazed at the ability of that small instrument to fa-

cilitate a measurement of something as minute as a wavelength of visible light. I went to the library that day to obtain further information and found more interesting information. I decided then to do more research and experimentation which marked the beginning of my project.

Then I went to the city library and checked out books on physical chem-

istry, atomic physics, the theory of magnetic waves, and chemical spectroscopy. I also obtained additional information from a neighboring scientist dealing with spectroscopic equipment who advised me in my choice of equipment. I also secured information on the probability of obtaining the spectra of a certain element from a scientist working at the University of Chicago.

I felt now that I had enough usable information to at least begin experimenting in a scientific manner. As all scientists would, I wanted to verify what I had read instead of taking the material for granted. I mapped out a small outline of my procedure.

I started by adjusting my equipment and obtaining the salts of several metals and nonmetals that give simple visible spectra. By dipping a platinum wire into the salt and placing it in the flame of a Bunsen burner directly in line with the slit and the grating, a spectrum is given off which can be measured with the spectrocope. Since I was working alone and the method of exciting the salts was cumbersome and required constant adjustment to maintain a measurable spectrum, I decided to use a carbon arc with a hollowed-out cathode to contain the material to be excited. When the material is placed in the cathode and sufficient voltage to maintain an arc is placed across the rods, the light is collimated and passed on to the slit. The results were better than those obtained by the Bunsen burner method. I selected the salts of lithium, strontium, potassium, and calcium to be excited, and I took readings that seemed at a glance to be appropriate to the element used. I found that I could make several

"runs" by using different cathodes for each, thus allowing more experiments in less time without time wasted in cleaning and cooling.

I verified my results by using the tables in the back of the book, *Chemical Spectroscopy* by Brode comparing the bright lines given in the tables with my lines obtained in the experiment. Of course, because of the physical limitations of the spectrocope, my results varied anywhere from 10 to 150 Angstrom Unit depending upon the concentration of lines, such as a triplet or quadruplet or just two or three close lines. In these groups the lines appeared as one large line because of the low resolving power and poor light gathering optics of the spectrocope.

When a line did not seem to check in the spectrum of an element, there were two possibilities of error. Either I had taken a wrong reading or there was an additional element in the cathode which was giving the line. I then did the experiment again and paid particular attention in measuring the line. If I had read the line correct the first time, I took the cathode used and marked it as one which contained impurities. To use this rod again, I shortened it by removing the contaminated part and forming a new cup in the rod. When I had conducted experiments with all of the salts, I had a table of my own which were the lines that I could obtain under ordinary conditions for the certain elements.

There remained another group of elements that I had not experimented with. These were the gases. I had Geissler tubes available which contained helium, argon, neon, mercury vapor, and hydrogen. In the center

of each tube there is a constriction to intensify the light at that point. This constriction is placed directly in front and almost touching the slit. By passing 6 volts of D.C. current from the secondary of an induction coil through the tube, a visible spectrum is produced.

The results obtained from these tubes were satisfactory enough to be within my experimental error. Particularly noteworthy is the fact that the lines obtained from the hydrogen agreed amazingly well with the calculated lines of hydrogen when the factors involved are rounded off to a certain extent.

Now that I had tables of wavelengths of common, simple-spectra elements, I could start simple chemical identification analyses of unknown materials, being able to iden-

tify those elements which give visible spectral lines of the bright class. Soon I will have a better quality spectro-scope with a better grating and more light gathering power with which to measure the wavelengths of the light given by the excited elements. This instrument will reduce the errors and the uncertainty in the measurements.

My objective in the project is an objective one: to experiment with the elements of spectroscopy including spectral analysis in an attempt to acquire a certain proficiency in the processes of chemical spectroscopy. Eventually with constant effort, I am sure that I will be able to find draw backs and misleading errors in my methods. By elimination of these undesired qualities, I hope to obtain a practical working knowledge of spectroscopic analysis that will be an asset in my chosen career.

Crystal Analysis by X-ray Diffraction

by KURT RUDAHL

Greenwich High School, Greenwich, Conn.

Given Honors in the 18th Science Talent Search

➤ IT IS FREQUENTLY of great value to know something about the nature of a crystal, even when the substance is not known. One of the most useful parameters of a crystal is the distance between the planes of atoms (or ions). My recent work has been to investigate the use of X-rays for this purpose, and to make a machine to do this.

The theory behind this sort of analysis is comparatively simple. It is well known that a wave will be diffracted to a large extent if passed through a hole which is small com-

pared with the wave length. While matter is too coarse to actually have a slot constructed from it for X-rays, the spacing between the individual atoms in a crystal is of the right order of size.

Thus, X-rays fired into a crystal will be diffracted in all directions. However, rays diffracted in the same direction from different planes of the crystal will have traveled different distances and will, therefore, tend to be out of phase; only when the extra distance traveled is equal exactly to a wave length or to some multiple

of a wave length will the rays be exactly in phase and thus produce no cancellation. When the extra distance is one half the wave length, or some odd multiple of it, the rays will be 180° out of phase and thus cancel each other completely.

Several methods have been devised to utilize this effect. The original method consisted of firing the X-rays through a crystal to register on a photographic plate. This resulted in a pattern of spots from which the necessary information might be completed. The principle disadvantage of this process was the difficulty in interpretation of data.

Another method, in wide use today, consists of making a beam of X-rays incident upon the face of the crystal. The crystal is at the center of a cylinder of photographic film and, as it rotates, the rays will vary from completely cancelled to not-at-all cancelled at various points on the film.

A major disadvantage of both of these methods is the necessity of having a large crystal, which is frequently impossible. Another process, using a fine powder of the material, is used frequently now. This works upon the theory that, with a large number of very small crystals, some of them are very likely to be in each of the positions for maximum, minimum, etc., exposure. The detector for this method may be either a photographic plate in which a series of rings is produced, or a strip of film similar to that used in the second system.

The actual production of a machine is never as simple as the theory. In undertaking this project, I mentally subdivided it into three parts: the

X-ray tube, the power supply, and the detector mechanism.

I had originally intended to make the tube, using a copper anode and a directly heated cathode. With this in mind, I bought a quantity of glass and a blast burner with which to experiment. By removing the filters from my mother's vacuum cleaner, I was able to substitute it for the compressed air. After much experimenting, I decided that I couldn't make the necessary large joints in the glass without an annealing furnace. This, coupled with the fact that the vacuum pump that I had counted upon borrowing had had to be sent back to the factory for repairs, forced me to abandon this approach.

At this point I was put in touch with a Mr. Cooke of Machlett Laboratories (Stamford, Conn.), who was kind enough to loan me a tube (a factory reject, but still operable) of a type which is manufactured there. The tube, while not designed for X-ray diffraction purposes, has served quite well.

The heart of the power supply is an R. F. transformer operating in the neighborhood of 0.5 m.c., and with a very low efficiency. Most of the design was on a trial-and-error basis, as information concerning the optimum placing of the three coils, the efficiency of the transformer, etc., was not available. Also, there are many make-shift arrangements of a rather questionable nature; their only excuse being that they work. An example of these is the power for the heaters of the oscillator tubes, 4 type 211, which require 10 v. at 3.25 A. each. I had planned to use a 12 v. step-down transformer with a voltage dropping

resistor in the primary. However, due to the fact that my home, where the equipment is, is at the end of a power loop, and because of the high current drawn, not only was there no need of the dropping resistor, but the voltage at the tubes was below 10 v. To supply the correct voltage, my entire power supply is working out of a "Variac" supply.

While the plate voltage across the tube can be computed once the wave length of the output is known, this information could not be obtained while the supply was under construction; and as I am not in possession of a voltmeter with a range of 50,000 v., I could only approximate the voltage by measurement of the arc length and applying this to a graph of length versus voltage. Also, I was unable to discover a commercial R. F. ammeter for as low as 10 a. for determining the current drawn by the tube. Since the current was rectified, I was able to use a D.C. milliammeter for comparative readings; however, I was able to get no idea of the absolute value of the current. I am presently trying to make a meter of the hot-wire type which will measure the current-equivalent and may be calibrated on D.C.

Before designing my detector mechanism, it was necessary to decide which of the three methods mentioned earlier I should use. I decided upon the powder method as being the easiest to use as well as being the most useful. Not only does it eliminate the need for a single large crystal, but it also eliminates the difficulty of interpretation inherent in the first method

and the need for *exact* centering of the specimen inherent in the second method.

I decided that my detector would be a cylinder of metal (a section of a fruit juice can covered with lead sheet) fitted with a light-tight cover and with a strip of 35 m.m. film around the inside. (I do the developing myself.) The X-rays, after leaving the tube, pass through a pair of holes in the lead sheet to produce a fine beam. They are then admitted to the detector and allowed to strike the sample in a thin-walled aluminum container in the center, from which some are scattered to the film. Obtaining satisfactory pictures takes several hours due to the low power of X-rays involved.

Throughout my tests I have exercised extreme caution, with the liberal use of lead shielding and provision for remote removal of power if trouble should develop. Even with the shielding, I have never stayed more than a few seconds in the proximity of the tube while it was working.

Because of certain unfinished elements, such as the hot-wire milliammeter to permit measurement of current used, the aims of the present project are not fully satisfied. The project is still in process. And, in addition to having an apparatus for determining crystal analysis by X-ray diffraction, one of the definite gains is that I now possess an X-ray generator with which I intend to conduct other experiments, such as studying the electronic structure of the atom.

✓ Answers to CHEMISTRY QUIZ on page 37.

A, 2; B, 2; C, 3; D, 3; E, 3; F, 4. ✓

Solid Inorganic Rocket Fuels

by DANIEL MADISON BYRD III

Northside High School, Atlanta, Ga.

Given Honors in the 18th Science Talent Search

► THE OBJECT of my project was to obtain the best possible fuel for use in rockets with the material available to me. To build a liquid fuel rocket would have been impracticable for my purposes so I did not work with liquid fuels.

After having examined organic fuels very closely, I decided against their use. They were hard to make or to obtain, expensive, and explosive. This well defined what I had to work with.

Of course, I did not begin from this point of view. It came out of my experimentation in the field of rocketry, one of my hobbies long before the advent of the sputniks. I did not outline my project until October of 1957. Then I was making small solid fuel rockets to test air resistance bodies. I had used U. S. Army composition gun powder in rockets and, noticing the poor results obtained, decided to find a better fuel.

The main object of a fuel is to give more force or acceleration to the body. Several measurable things influence this; as the rate of burning, the efficiency of burning, the weight of the matter ejected, etc. I decided to break down the thrust of a rocket into some of these components so I could observe and compare differences between fuels in the laboratory.

Using the same three components the U. S. Army gun powder had had

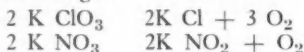
(potassium nitrate, charcoal, and sulfur), in four experiments from December 12, 1957 through January 20, 1958, I found the best percentage of oxidizer to use. I mixed equal amounts of powdered charcoal and sulfur with varying amounts of oxidizer; recording the burning of the mixtures on a chart in terms of brilliance, speed, ease of ignition, excessive sulfur, consistency, and amounts of residue. All these comparisons were visual and had no numerical basis. Therefore I could not grade the various mixtures but could only find the best ratio which was 3-3-16 or 18 or 72% to 75%. (Nearly the same as U. S. Army gun powder.) However, after repeating the experiment several times I decided my results were accurate.

I also conducted two experiments to ascertain the effect of varying consistencies of constituents using coarse charcoal on February 4 and 5, 1958. The best amount of oxidizer was 3-3-18 or 20 or 76% to 78%.

On February 15, 1958 I ran two experiments to test the effect of high humidity on the best percentage of oxidizer. It was the same (72% to 75%) but generally ignition was harder, burning was slower, and greater amounts of residue were left.

Now I introduced a new oxidizer, potassium chlorate into my fuels. In a chemical equation it appears to be

three times as powerful as potassium nitrate, however, it has a greater atomic weight.



In two visual comparison type experiments on February 1 and 3, I found the best percentage of potassium chlorate in gun powder to be 48 when mixed with equal amounts of charcoal and sulfur.

Now I decided to invent a new method of testing as visual comparison of fast burning powders is very hard. The best way I found was to chart the burning times of equal quantities of fuels in a brass spool.

I checked the amount of charcoal to sulfur combined with 72% potassium nitrate on January 9, 1958 by both methods and found the result nearly the same. This gave me an end product with from 16% to 18% charcoal and 9% to 11% sulfur.

On February 4, 1958, again timing the burning period, I checked the potassium chlorate percentage and found it correct, and I proved that the same percentage of oxidizer was best for equal amounts of charcoal as well as for gun powder made with 11% sulfur and 16% charcoal.

Checking on the efficiency of this end product, I found that 1114 parts of oxygen out of 14456 parts oxygen was unburned assuming complete and efficient combustion of the gun powder.

Now I decided to introduce a new combustible into the fuel. I decided on a burnable metal and used zinc as it was easily available. On January 21, 1958 I found that the best percentages of constituents in this fuel

were 6% zinc and 22% sulfur with 72% potassium nitrate.

Another problem of mechanical nature that I ran into here was ignition. Previously I had only used chemical means but this became increasingly inadequate and insufficient as the heat of ignition in metallic fuels is much higher. I began using a resistance-type apparatus at the suggestion of Dr. William Eberhardt of Georgia Tech and I soon modified this with a transformer to suit my needs. Using nicrome wire and from 12 to 16 volts, I obtained a cheap and efficient means of ignition.

Because of the prominence given zinc and sulfur fuels at the time I decided to experiment with them. I found the best mixture to be 60% sulfur and 40% zinc. Higher proportions of zinc produced explosions too often. A chemically calculated "perfect" zinc-sulfur fuel was in the neighborhood of 30%-70%, so some zinc must not be burned in the motor.

Aluminum was the other metallic fuel I decided to use. It is nearly as combustible as zinc and much lighter. In practice, however, aluminum-sulfur mixtures were almost impossible to ignite and very slow burning. An article in *Metal's Progress* by Haffner stated that the addition of small amounts of aluminum to zinc greatly increased the efficiency of zinc in pyrotechnics. Working on this basis I found the best mixture to be 31.5% zinc, 10.5% aluminum, and 58% sulfur.

At this time I also found that the addition of small amounts of potassium chlorate (2%) defined the flame and made the fuel burn consistently.

By accident I found that a mixture of zinc substitute gun powder and

potassium gun powder gave a very efficient fuel. Experimenting I found the best ratio to be 1 to 3. This gave a fuel of 2% zinc, 24% charcoal, 18% potassium nitrate, 36% potassium chlorate, and 20% sulfur. Varying these proportions I found the best percentages to be 40% sulfur, 15% charcoal, 25% potassium chlorate, 15% zinc, and 5% aluminum. Using a re-

action-type apparatus with a rocket suspended from a balance point and measuring the reaction in degrees, I established this as the best fuel of all those I had tested. Of course, I could carry on much more experimentation in this field, and I probably will; but for the moment this fulfills my need and answers the basic question asked.

Isolation of Organic Chemical Components of Lichens

by WILLIAM EDWARD GASS
Mena High School, Mena, Arkansas

Given Honors in the 18th Science Talent Search

► THE LICHEN GROUP of thallopyte plants was chosen for this study during the latter part of 1956. Originally a topic for required class research, it developed into an extra credit research project. The bases for this choice of subject were the following points: 1. Information seemed to be almost impossible to obtain, indicating that this field was not crowded and that ample room for investigation remained. 2. The problems presented would be complex enough to be challenging and entertaining. 3. The physical characteristics of the lichens indicated that the lichen is a hardy little individual indeed, making the keeping of suitable specimens quite easy.

The subject seemed worthy of further study.

The first step in the study was to acquire a rudimentary knowledge of Lichenology by studying terminology, life cycles, history, and processes carried out by lichens. This brought about the discovery that the lichen is

not the simple little plant it had at first been assumed to be. The problems turned out to be as exacting and as complex as in any field that could have been chosen.

The next step was to establish a definite objective. My interests seemed to be in the organic substances produced by the plants rather than in the physiological processes or cellular components of the lichens. But to avoid restricting my research, the problem was left open until results of experiments and the curiosity generated could evolve a definite objective.

The first attempts to isolate some of the organic constituents of lichens were made using procedures outlined by Dr. Mason E. Hale¹. These were re-crystallization processes, carried out on a microscope slide. The substance was first dissolved by a suitable solvent and then re-crystallized by the

¹ Mason E. Hale, "Lecture Notes: Lichenology," 1957.

use of a special reagent. Typical solvents are ethanol and diethyl ether. Reagents were mixtures of acetic acid and/or glycerine with one of the following:

o-toluidine, quinoline, p-Phenylenediamine or aniline.

The results obtained by this method were considered inadequate since they were on a very small scale and not at all consistent. Chromotography was also discarded. Results obtained were even less conclusive than before.

It was decided that a new method of extraction was needed.

Diffusion Method

The diffusion method came as an outgrowth of the re-crystallization experiments.

In working on re-crystallization and chromatography processes, a difference was noted in the solubility of lichen substances in various solvents. It seemed probable that this difference could be utilized in the separation of the constituents.

In this method the lichen is placed in a beaker of boiling water to which has been added a slight amount of a strong base, such as KOH or NaOH. This breaks down the cell walls of the lichen fungi and apparently causes the substance to become soluble. The mixture is then cooled and a volatile acid is added until the mixture has a pH of about 6.

The filtered solution is then placed in a large stoppered flask with an equal quantity of an immiscible solvent. The mixture is shaken up and allowed to settle. The two layers are then separated in a burette tube used as a separatory column. The layer of immiscible solvent is drained off and

evaporated till only crystals (or a gummy deposit) remain. Some problems have been encountered because of emulsification of the solvent.

Results of Test

Due to the natural variations of lichen strains, the results that have been obtained have not measured up to expectations.

Some lichens give very little or no products by this method while members of the same species (which can't be told apart by the naked eye) give very pronounced results.

The color of the substances thus far produced range from a dark brownish-black to a brilliant reddish-orange. The physical composition ranges from a gummy deposit to a fine powder. A few have some of the properties of organic dyes, i.e. brilliant color, soluble in water, and color change with changes in pH. The stains caused by these products is often hard to remove.

With the experimentation incomplete, a definite conclusion to the problem undertaken cannot be drawn. However, the following things were concluded: Lichens contain organic pigments and substances which can be extracted and studied. The properties of these substances are as widely varied as the lichens from which they come.

Most significantly, the concentration and composition of these products varies among the individual lichen strains.

The diffusion method holds promise of being a satisfactory method of isolating in crystalline form some of the complex organic substances found in lichens.

Paper Chromatography

by PATRICIA ANN MARIE NELSON

North Phoenix High School, Phoenix, Arizona

Given Honors in the 18th Science Talent Search

► I BECAME INTERESTED in paper chromatography about two months ago while talking to the director of an Arizona Laboratory. My work in paper chromatography thus far, has been very limited as I am still learning the basic principles of this relatively new field in chemical analysis. The work and reading that I am doing now is just the foundation for what I hope to do in the future — classify bacteria from their chromatograms.

In my experiments on chromatography, I chromatographed three different indicator dyes and made chromatograms of a mixture of the three dyes. Through this experiment I was able to understand more fully the principles of chromatography.

Basic Principle

Chromatography is based on the principle that moving liquids carry materials dissolved in them from one place to another place. My moving liquid was a solution of:

- 30 n-butyl alcohol
- 10 ethyl
- 10 2N NH_4OH_2

My materials were three indicator dyes: congo red, phenol red, and brom phenol blue, and a combination of all three. Eighty mg of each dye was mixed with 100 ml of ethanol. In the combination, I combined 80 mg of each with 100 ml of ethanol.

From one place to another place referred to my No. 1 Whatman filter paper which was in strips.

My apparatus consisted of several pieces of simple lab equipment. I used a large circular glass tank with a circular glass top. The edges were ground to make an air tight container. In the middle of the top was a hole lined with rubber. Through this hole I suspended a glass rod with radiating rods at one end. The paper strips with the substance to be chromatographed were hung on these rods.

Substance Applied

After preparing the solvent I put about $\frac{1}{2}$ inch in the tank. Then I prepared the paper. I cut the strips the same length and made equal loops at one end of each piece and secured the loops with a pin. I drew a line about 1 inch from the end without the loop and placed an x on this line. This was the point at which I applied the substance. I used lead pencil because lead will not affect the chromatograms. I applied a small drop of the solution to be chromatographed by means of a small capillary tube. In this way I was able to get a uniform dot on each strip. After I applied the spot of congo red, phenol red, and brom phenol blue to separate strips and the combination of the three to a fourth strip, I fumed the strips with NH_4OH_2 . I did this because the dyes changed to their acid colors on stand-

ing and I wanted to see them in their basic color.

After these steps were taken, I placed each strip on a different rod and lowered it in the tank so that $\frac{1}{4}$ of each strip was immersed in the solvent.

Within ten minutes, the solvent front had reached the line at spot of application. I started to record the changes at ten minute intervals but after 20 minutes there was not enough change to record so I recorded the change at intervals. These are the changes that I recorded.

- 1 — strip with congo red red
- 2 — strip with phenol red purple
- 3 — strip with brom phenol
blue blue
- 4 — strip with combination of three
10 minutes

- 1. no noticeable change
- 2. spot feathered a little at top
- 3. whole spot moved a little
- 4. blue moves up a little, purple spot remains

20 minutes

- 1. no noticeable change
- 2. whole spot moved a little, kept round shape
- 3. spot moved but began to spread lengthwise
- 4. blue spot moved the same as in (3), purple moved about the same as in (2). small red spot became noticeable.

40 minutes

- 1. spot moved a little bit
- 2. traveled more, began to spread lengthwise
- 3. traveled more, spread more
- 4. blue same as in (3), purple same as in (2), red more noticeable, moved very little.

60 minutes

- 1. moved very little, still round
- 2. about the same as at 40 min., oblong shaped
- 3. moved up some, elongated
- 4. spots in same positions as in other three chromatograms. separation complete.

Although separation was complete after only 60 minutes, the substances continued to move up the paper for $5\frac{1}{2}$ more hours. At the end of that time the red congo had moved very little and part of it was still on the line. The phenol red had moved about $\frac{1}{3}$ of the way up the paper and the brom phenol blue had moved about $\frac{2}{3}$ up the strip.

After the mixture of the three dyes had stood for about two days, I noticed that part of it had settled on the bottom of the bottle. Without shaking it up I applied a small drop as I did before and ran a chromatogram on it. The spots of brom phenol blue and phenol red appeared the same as on the previous chromatograph of the combined mixture, but the congo red spot was smaller and lighter. I hypothesized that it was my congo red that had settled on the bottom. I shook the mixture and ran another chromatogram. I found that the spots were the same as in the first one.

Repeat Experiment

I ran the entire experiment again. This time I heated the paper first to drive off some of the water contained in it. The only change in this experiment was that it moved a little slower. The end results, however, were the same.

After the chromatograms dried I found that the phenol red and the

brom phenol blue had turned to their acid color. I fumed them with $\text{NH}_4\text{-OH}_2$ and they turned purple and blue respectively. The congo red spot had stayed fairly round but the other spots lengthened and toward the end widened a bit.

The principles of Chromatography are not difficult, but much work is required and many records have to be kept (as with any scientific research). Most of the time a person will not be working with knowns but with unknowns. In order to identify these unknowns a person should keep a table of rf values. The rf value is

dist. material moved from orig. pt.

dist. solvent traveled from same pt.

By running chromatograms on knowns you can set up your own

table of rf values. This table comes in handy when trying to identify unknowns.

Also a list of factors that will speed up the action, slow it down or change it in some other way is helpful. Different solvents, grades of filter paper, temperatures and other variables will affect the results of the chromatogram. Many times the substances that are separated will have no recognizable color in ordinary light. Then it is necessary to use ultraviolet light or reagents to identify the substances.

Since minute quantities can be separated by chromatography its future use in chemical analysis will be very important, and it will take a place among the other methods of analysis that are known today.

Vitamin Deficiency

► CHEMICALS that kill plants by creating a vitamin deficiency were described to scientists at a meeting of the Northeastern Weed Control Conference in New York.

Dalapon and related compounds interfere with the formation of an important vitamin, pantothenic acid, essential to the plant's growth and development, Dr. James L. Hilton said. It does this, the U. S. Department of Agriculture researcher explained, by upsetting normal enzymatic reactions.

Pantothenic acid is made within the plant when the two chemicals, pantoate and beta alanine, attach themselves to specific sites on a certain plant enzyme. Since dalapon also readily attaches itself to the same site as that normally reserved for panto-

ate, the enzymatic reaction cannot take place and no vitamin is made.

Evidence that dalapon (2,2-dichloropropionic acid) and its related compounds act to inhibit plant growth was first indicated by test-tube experiments with ordinary yeast, Dr. Hilton said. Yeast's failure to grow after treatment with the herbicide was found to be caused by pantothenic acid deficiency.

Similar experiments with barley, oats and ryegrass have given the same results. Also, the addition of pantothenic acid overcame the deficiency in dalapon-treated plants.

Co-workers with Dr. Hilton were Walter A. Gentner, Leonard L. Jensen and Jesse S. Ard, all of the USDA's Agricultural Research Center, Beltsville, Md.

A Chemist Looks at Solar Energy

A Challenge to the Creative Chemist

by MERRITT L. KASTENS, F.A.I.C.

Assistant Director, Stanford Research Institute, Menlo Park, California

Reprinted from THE CHEMIST, Jan.

► SOLAR ENERGY, which must inevitably assume an important role in our energy supply picture, presents its particular challenges to the chemical professions. Many technological hurdles yet stand in the way of wide-spread practical utilization of the energy from the sun. A significant number of these obstacles will require discoveries and developments in chemical technology for their solution.

Two basic characteristics of solar energy are at the root of the technological, and hence the economic, difficulties in its application. The first is its inherently low concentration. The sun shines on the just and the unjust, the rich and the poor, but at best it shines with an intensity of about one kilowatt per square yard. Calculated for a large area, the available energy might be impressive. However, it must be collected, concentrated, and for most purposes converted into another form before it is of practical use.

A tremendous asset of solar energy is the fact that it is available where you want it. There are no costly transmission costs or transmission losses. But there is a compensating difficulty — the sun's energy is often not available when you want it. This energy supply is intermittent on a daily cycle and is often interrupted by adverse weather. This immutable characteristic is the second condition which must be overcome for practical appli-

cation of this energy. Some way must be found to distribute this intermittent source uniformly throughout the year. The chemical engineer and chemist must contribute to the solution of these central problems.

The sun's energy is most easily collected in the form of heat. Whether the heat is later used for distilling water, driving an engine, or for heating and cooling a house is a secondary consideration. Considerable worldwide research has been devoted to the chemical design of solar collectors. In the U. S. this effort has been directed primarily toward flat-plate collectors involving no concentration or focusing of the sun's rays. However, the concentrating collectors which make available a more concentrated source of heat also have their partisans. Flat-plate collectors, and to a lesser extent concentrating collectors, are dependent upon a "hot-house" effect to prevent loss of the collected heat through re-radiation, and so are much dependent upon materials with special light transmission and absorption characteristics.

One of the most exciting developments in the field of solar technology was the announcement by Dr. H. Tabor of the National Physical Laboratories of Israel that a material had been developed which has different absorption characteristics in different visible and thermal radiation wavelengths. This material, very absorbent

to visible light, appears quite black to the eye. However, it is reflective to the longer wavelengths of infrared heat radiation. Therefore, when the radiant energy from the sun is absorbed in a body coated with this material, it is essentially trapped and will not re-radiate as heat radiation. Dr. Tabor's proof that such a material can be prepared has greatly increased the optimism of solar research people working in collector design. As this is the first successful attempt in this direction, it is almost inevitable that still better materials can be developed. A cheap coating with a broad differentiation between its absorption in the visible spectra and in the infrared will tremendously increase both the engineering efficiency and the economic feasibility of solar collector devices. Dr. Tabor's discovery has permitted the design of the first successful steam-producing flat-plate collector. Further advances with such coatings will permit operation of flat-plate collection at still higher temperatures with a resultant increase in the available temperature differential and a concomitant increase in the cycle efficiency of any device connected to the collector.

The solar engineer also has critical need of materials for special light transmission properties and stability. Obviously a material with differential transmissivity which would transmit the visible incoming light and be opaque to the re-radiated, would be as valuable as the Tabor type surfaces. To date, no such materials have been devised.

Even less demanding is the specification for a material which would be highly transparent to visible light,

stable to photochemical degradation, lightweight, and easily fabricated. Every new transparent plastic has been eagerly examined by solar researchers to see if it might afford a substitute for glass in solar devices. So far none has met the test. Known transparent plastic materials yellow and embrittle with prolonged exposure to sunlight. The hope for a plastic with satisfactory properties persists, since the ease of fabrication and the lessened structural demands resulting from its light weight promise a substantial reduction in the cost of solar devices.

A variation of the requirement is found among the builders of solar furnaces and high-temperature concentrating devices. The designer of a solar furnace is limited by the properties of existing materials to the use of back-silvered glass elements for his reflector. The weight of such elements dictates a massive supporting structure which increases cost. Polished aluminum or other metal elements have lesser weight and more complete reflectivity. However, there is no coating available which will protect these surfaces against corrosion and erosion without introducing great loss in reflectivity. A truly transparent, stable plastic coating, not now available, would answer this requirement.

A more exotic challenge to the chemist is afforded by the recently developed barrier layer cell for the conversion of radiant energy into electricity, known as the Bell solar battery. These cells are composed of highly purified monocrystalline silicon impregnated with controlled impurities. Pure silicon is expensive. Grown into large single crystals it is more so. When carefully sliced and treated to

produce a solar cell, its cost approaches \$25 a square inch. The application of such converters, even if they approach the theoretical efficiency of 22%, will be extremely limited.

This suggests a technique for producing such semiconductor surfaces continuously, perhaps as a coating on a plastic or metallic sheet. Such a fabrication technique, perhaps based on an epitaxy phenomenon, might reduce present costs of such devices up to a thousand-fold, which would bring such solar energy converters into economic competition with many sources of electrical energy. Perhaps a chemist or chemical engineer can supply the key to such a technique.

What can the chemist do to counteract the inherent intermittency of solar energy? Throughout history, the problem of storing energy has largely frustrated the efforts of man, although it is the common skill of the lowliest form of protoplasm. Man's best achievement in this direction seems to be the galvanic storage battery, clumsy, inefficient, and expensive. If the storage battery had really been improved in a major way in the past fifty years, the electric generating capacity in this country might operate at something more than the 50% load factor at which it operates today. A highly efficient storage battery would solve the problem of solar energy storage. Pending the discovery of such a device, there are other techniques which warrant investigation.

The storage of solar heat as heat of fusion in molten salts has often been considered. Unfortunately, nature's characteristic perversity has been demonstrated once more in the fact that the obvious salts which melt

in the proper temperature range resist nucleation in recurrent melting and solidifying cycles. Even more critical is the interconversion between various hydrates of the salts which often results in the formation of a solid precipitate and a saturated solution rather than the solid phase of the hydrate. It seems reasonable that more satisfactory salts must exist for this purpose, but they have not yet been discovered or produced.

A possibility for the storage of heat which has been less well explored is suggested by the heat of dissociation or heat of formation of various unstable chemical combinations. Theoretically it should be possible to store heat from the sun in such a system under proper conditions. But this possibility awaits the initiative of an enterprising chemist.

The most common mechanism for the storage of energy, used by plant and animal life, is the elevation of a chemical system to a higher energy level. Chemists employ this mechanism when they conduct any endothermic reactions, though they do not normally think of it as an energy storage operation, except perhaps when the end product is a special fuel or an explosive. Photochemistry is the name applied to that branch of science which deals with the direct conversion of radiant energy into chemical energy. Photochemistry has usually been limited to the processes characteristic of the plant cell, with an extension into the field of photographic chemicals. This limited perspective is not warranted if we would consider the exploitation of the sun's radiation. Other photochemical reactions which are known, at least em-

pirically, warrant investigation as possible mechanisms for the conversion of solar radiation. There is every reason for optimism in expecting that such chemical conversion mechanisms might be as efficient, and probably less expensive, than the solid-state physics mechanisms exemplified by the silicon cell.

Reactions are known to exist by which water may be decomposed through exposure to sunlight with the consumption of no additional material. One of these systems, involving cerium salts, has been rather fully explored. Others appear feasible in theory. These reactions remain a blank in the records of chemistry simply because the non-biological chemist has largely passed over the field of photochemistry. The potential practical significance of these reactions is immeasurable. The production of hydrogen and oxygen in ideal proportions to provide a perfect fuel, while consuming nothing but water and sunlight, outdoes the prestidigitation of producing nylon stockings from coal, air, and water. Such conversion mechanisms inherently solve the storage problem since in a sense energy can then be stored in pressure bottles. Should electricity be the preferred form for the energy, an existing fuel cell (the Bacon cell) is already available to convert the chemical energy into electrical energy at efficiencies in excess of 80%. Thus a photolysis cell that would operate at 15% efficiency, combined with an 80% efficient fuel cell, would already equal the best efficiency, 12%, obtained in the solid-state solar battery.

Photogalvanic cells (light-motivated wet cells) to produce electricity have

enjoyed less attention than photolysis reactions. There seem to be no theoretical reasons for discarding the possibility of photogalvanic cells. The non-development of these devices must be attributed solely to chemists' lack of interest. Still the photogalvanic cell offers the possibility of a device which would collect, convert, and store solar energy in one operation. Cells have been constructed with moderate storage capacity, though usually they are simple conversion devices. It would seem that photogalvanic mechanisms should be explored at least to the extent of defining their apparent limitations.

Other photochemical reactions are known or suspected which could be of considerable economic significance to industrial chemistry. In the air over Los Angeles on a smoggy day there are tons of ozone and other high oxidation potential compounds created by photochemical reactions under what, from the point of view of chemical processes, must be considered very adverse conditions. Reactants are in low concentration, often transitory, and under conditions of temperature, pressure, and contamination which would be the horror of a fastidious chemical engineer. And still a product is produced which in the channels of commerce would be worth thousands of dollars. Even more exotic is a recent discovery of the production of atomic gases in the upper atmosphere formed presumably through the action of the sun.

Then there are such reactions as photopolymerization occurring in elastomers and certain plastics. Investigators have reported the production of polymeric materials having unusual

physical and chemical properties, through the use of light polymerization. In some cases these polymerizations will occur not only under less rigorous conditions, but actually faster, through the action of sunlight, than they will by the normal thermal cure. These polymerizations may be related to the reactions which plague us in the deterioration of finishes and plastic materials in the sunlight. It also seems reasonable to speculate that the special products of photopolymerization are formed by a mechanism somehow related to that of high-energy radiation polymerization.

One of the earliest practical applications of solar energy will be in the high-temperature solar furnace. The U. S. Air Force recently announced plans to construct a research furnace in New Mexico. A few small furnaces are now operating in universities and industrial laboratories in the U. S. Several large furnaces have been in operation for some years abroad. Most of this work is aimed at the exploration of high-temperature alloys and ceramic materials. Solar furnaces are ideally suited for this, since they afford high temperatures under easily controlled conditions. These same characteristics make solar furnaces seem useful for investigation of high-temperature reactions. The only major program involving a solar furnace in the field of high temperature chemical reactions is one in Algiers, where a pilot installation has been built for the oxidation of atmospheric nitrogen for the ultimate production of nitrate fertilizers. The Algerian installation has proven the feasibility of "freezing-in" the reaction product with high efficiency. But the pilot plant has been

plagued with engineering difficulties, not unexpected since it is operating at unusually high temperatures and unfortunately the operating budget for the Algerian work has disappeared.

Little is known about chemical reactions at sustained temperatures in excess of 3000°C. Interesting speculations can be made about what might be expected. With the increasing availability of high-temperature solar furnace facilities, it behooves chemists and chemical engineers to give thought to what chemical reactions might be achieved under the conditions such installations afford.

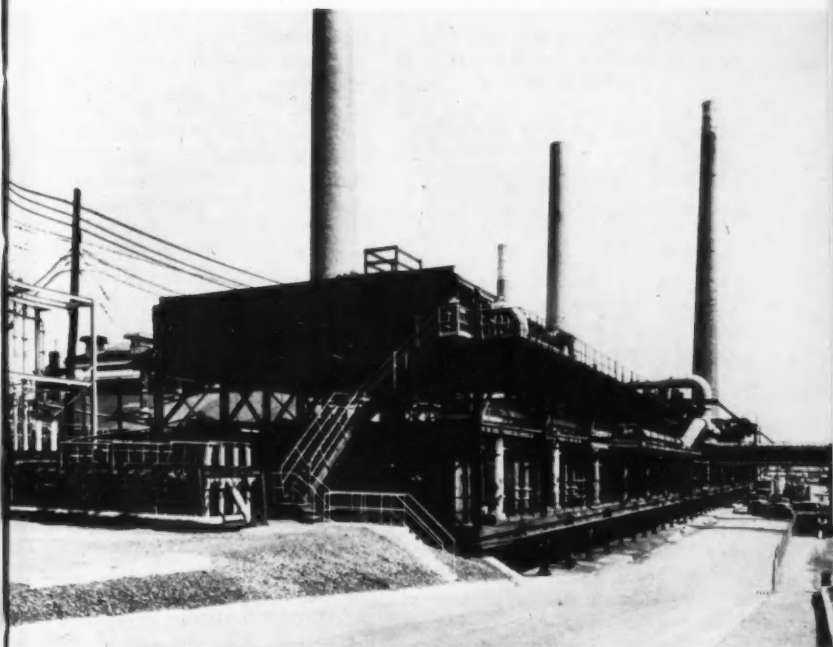
It is pertinent to note that Lavoisier's epochal experiments were conducted on an early solar furnace. If oxygen could be discovered because of the unique facility afforded by a solar furnace in Lavoisier's day, it is not too visionary to anticipate further significant discoveries with the much improved solar furnaces soon to be available in this country.

The exploration of the potentialities of solar energy has a long, not always honorable history, dating back to the days of Archimedes. In spite of this long history it has failed to enjoy a pronounced vogue during the era of modern applied research. Efforts toward the objective of utilizing the sun's energy have been sporadic and isolated. Chemists and chemical engineers have played a part in these investigations, but in general do not seem to have grappled directly with the characteristically chemical problems of the field, yet these chemical problems seem to be central to further major advances. Their importance has been too long discounted.

Solar energy can replace a major

part of the energy supply of the world now provided by diminishing fossil fuel reserves. There are reasons to believe that solar energy will always be cheaper than nuclear energy for cer-

tain applications. It will be more easily accessible and require less complex apparatus. But before the economic reality can be achieved, the technological challenge must be met.



► AN ESSENTIAL STEP in large-scale manufacture of sulphuric acid is removal of acid mist from the main gas stream before it moves on into the conversion equipment. For many years this was done by filtration through coke, excelsior or similar substances contained in large boxes. In recent years, however, electrostatic precipitators have come into increasing use for this purpose. At the North Claymont (Del.) plant of General Chemical Division, Allied Chemical Corporation, a combination of both methods is currently in use. At two points in the long, double-decked row of coke boxes shown here, space has been made for a battery of Koppers' acid mist precipitators. These now handle primary cleaning of the mist-laden gases from the generating burners and supplant the upper tier of boxes. The gases then are passed through the lower tier of boxes for secondary cleaning. Since installation of the precipitators, the company has begun dismantling the top row of coke boxes.

For The Home Lab

N,N'-Tetramethyl-4,4'-Diaminodiphenylmethane

by BURTON L. HAWK

► DON'T LET the name of this experiment frighten you. If you can pronounce it, you should be able to make it. Or, maybe some of you will find that it is easier to make than to pronounce.

N,N'-Tetramethyl-4,4'-diaminodiphenylmethane is a reagent used in spot tests for lead and manganese, and also in the preparation of Auramine, a bright yellow dye. It is also known as tetramethyl base, tetra base, or just plain "tetra." We will compromise and call it tetra base.

Mix together in a 125 cc. Erlenmeyer flask, $6\frac{1}{2}$ cc. of dimethylaniline, $5\frac{1}{2}$ cc. of concentrated hydrochloric acid, $2\frac{1}{2}$ cc. of formaldehyde (40% solution), and $3\frac{1}{2}$ cc. of water. (The fractional measurements are included to make the experiment more complicated.) Now this mixture is heated for four hours under reflux in a water bath. Perhaps the easiest way to do this in the home is by heating on the kitchen stove. So, if you can persuade the lady of the house to let you use the stove in the interest of science, you may proceed as follows:

First, obtain an old saucepan (again, from the lady of the house in the interest of science), fill it $\frac{3}{4}$ full with water and heat to boiling. Second, insert a one-hole stopper in the flask containing your reaction mixture and then insert a straight glass tube through the stopper. It should extend about $\frac{1}{4}$ " below the stopper inside the flask and should extend upward

about two feet outside the flask. This long tube will enable you to boil the mixture without excess loss due to evaporation. Third, fasten the flask securely to a ringstand and immerse it (suspended from the ringstand) into the boiling water in the saucepan. And, finally, regulate the heat so that the water in the saucepan continues to boil moderately and continue heating for about four hours. You will have to add more water to the saucepan from time to time to replace that lost by evaporation.

After heating is completed, remove the flask from the water bath. While it is cooling, prepare a solution of 4 grams anhydrous sodium carbonate dissolved in 50 cc. of water. Add this to the mixture in the flask. After the effervescence ceases, shake the flask gently. The tetra base separates as a heavy oil which rapidly solidifies as the solution cools. Filter off the solid and dissolve a small portion of it in hot alcohol. Pour the alcohol into a watch glass and allow it to evaporate. The tetra base remains.

Test for Manganese

Dissolve a small portion of the tetra base in glacial acetic acid and keep this solution handy in a test tube. Now in another test tube, dissolve a very small quantity of manganese dioxide in about 2 cc. of glacial acetic acid. To this, add a few drops of the tetra base solution just prepared. A deep beautiful blue color is formed. If it is too deep, dilute by adding

more glacial acetic acid. This is a very sensitive test for manganese. This "diphenylmethane blue" can also be used as a dye. It is not, however, because of too much competition with many other blues which are better and cheaper.

Test for Lead

Place about 5 cc. of hydrogen peroxide (3% drug-store variety) in a test tube. Add one cc. of ammonium hydroxide and stir. Immerse a piece of filter paper in this solution; remove, and spread out on a flat surface. Prepare a very dilute solution of lead nitrate and add a few drops of it to the center of the filter paper. Carefully, heat the filter paper over a low flame or lay it on a hot surface. Do not allow the paper to catch fire or become scorched.

The lead nitrate solution is oxidized

to lead dioxide by the hydrogen peroxide. By adding a few drops of the tetramethyl base solution (in acetic acid), the blue color indicating the presence of lead is obtained.

Auramine is obtained by heating tetra base with sulfur, ammonium chloride, and salt in an autoclave while passing a stream of dry ammonia gas through. The reaction is quite involved and beyond the scope of a home laboratory. Auramine dyes mordanted cotton a brilliant pure yellow.

Unfortunately, we cannot conclude with the usual spiel enlisting the virtues of our subject compound. Because, alas and alack, tetra base is not important nor is it very useful. It is available commercially, however, for the express purpose of detecting the presence of lead and manganese, as we have described here.

Drug Outclasses Morphine

► A PAIN-KILLING DRUG that appears to be 10 times more powerful, less addicting and safer than morphine has been developed by scientists at the U. S. Public Health Service's National Institutes of Health.

The drug, labeled NIH 7519, is made from coal tar derivatives. It belongs to a new series of chemical compounds called benzomorphans.

NIH 7519 is reported to have pain-killing power at least 10 times that of morphine and 50 times greater than codeine. The drug has been used on more than 200 human patients suffering severe pain. Delivery room and post-operative pain are the specific targets that the scientists said the new drug affected.

Dr. Everette L. May, laboratory of chemistry, National Institute of Arthritis and Metabolic Diseases, developed the drug in collaboration with Dr. Nathan B. Eddy, chief of the Institute's section on analgesics.

Scientists have been working for years to separate the pain-relieving and addicting characteristics in substances having potency as great as or greater than morphine. Numerous drugs have been produced, but none proved useful. The newer drugs showed greater pain-killing results, but these were always coupled with greater addiction or other harmful effects.

Findings to date indicate that NIH 7519 is addicting too. But the exact

degree is still to be determined, Dr. May pointed out.

The final cost of the new drug to the patient has not been determined. Dr. May estimated that it will range between intermediate and high-cost drugs. It will be available by prescription only, he emphasized.

This synthetic drug may prove to be extremely important because there is an acute world-wide shortage of opium for medicinal use, Dr. Eddy said. Opium is the source of morphine and other powerful pain-relieving drugs used in medical practice.

Iran and Afghanistan, big suppliers of opium, are trying to wipe out ad-

diction. Hence, they have curtailed opium production. Turkey and India are now the only two legitimate producers of opium for medicinal needs.

Currently the drug is on clinical trial. Patients in Philadelphia, New York and Los Angeles are receiving it under careful observation.

The drug was supplied to NIH by Smith, Kline and French Laboratories of Philadelphia. New York Quinine, Abbott Laboratories of North Chicago, Mallinckrodt Chemical Works, St. Louis, and Merck and Company of Rahway, N. J., are investigating the possibilities of producing the pain-killer.

Limit Right to Bear Children

► THE DAY MAY COME when individuals will no longer have the right to determine how many children they will bear, without regard to biological and cultural consequences, Dr. George W. Beadle, geneticist and 1958 Nobelist in medicine and physiology, suggested as a result of the development of knowledge about heredity and genetics and the growth of world population.

Dr. Beadle, chairman of the California Institute of Technology's biology division, speaking at a Resources for the Future forum, said that decisions must be made about man's genetic future because:

Genetic knowledge we have attained "can be applied to directing our own evolutionary futures," but we shall "fail miserably unless it is done with more wisdom than so far demonstrated."

"With present rates of population

growth, something will have to happen before too many generations." Questions to be answered "will go far beyond science in their implications."

"Genetics will have a great deal to say about such things as the necessity of genetic diversity in populations, the biological consequences of interpopulation mixing and the effect of mutation rates that will result if exposure to artificial radioactivity is significantly increased over its present levels."

Dr. Beadle predicted that biochemists may, before long, be able to duplicate in test tubes the conditions under which "living" molecules arose on earth a few thousand million years ago.

Citing the recent discoveries that deoxyribonucleic acid (DNA) is the primary genetic material, in viruses and probably in animals including man, Dr. Beadle told how this new

knowledge of the stuff of the genes fills important gaps in our understanding of evolution.

Life can now be defined in objective terms, Dr. Beadle observed, as ability to replicate in the manner of DNA (duplication of molecules in the image of the original one) and to evolve through mutation (change of the genes) and natural selection.

Former vice president Henry A. Wallace, whose development of hybrid corn was largely responsible for adding within a few years at the end of the thirties 20% or 500,000,000 bushels to the American corn crop without adding labor or acres, declared in discussion of Dr. Beadle's paper that:

"Complete chemical and biological understanding of DNA and the chromosomes will sooner or later shake our social, political and religious life even more profoundly than the atomic bomb."

Mr. Wallace suggested that hereditary and health records will in the future be kept of all the people of the world, listing diseases, death causes, intellectual attainments, abnormalities, the blood types of each person by families. These would allow choice of marriage partners to avoid hereditary disease.

Mr. Wallace observed that world population now increases at the rate of 48,000,000 a year and probably 30,000,000 come from areas where the income per capita is less than one-tenth that of the United States and where illiteracy is more than 50%. These millions in the future will become the most powerful political force in the world.

The population explosion in the

long run threatens Russia more than the United States, Mr. Wallace believes. He is more concerned with the increasing lack of opportunity for these rapidly breeding people to demonstrate productivity in hope and joyous living than he is about possible inferior genetic quality.

Human growth was described by Dr. Beadle as follows:

"It is an unending source of wonderment that out of minute spheres of jelly-like protoplasm little larger than the point of a dull pin there should develop living beings like you and me — beings built of uncountable billions of molecules intricately organized and interrelated; capable of growth, adaption, memory, rational thought and communication; able to create and appreciate art, music, literature, religion, science and technology; and, above all, designed to hand down to the next generation the biological and cultural inheritance that permits this near-miracle to be repeated again and again. All this from the tiny cell that is the fertilized egg of man.

"If we could but expose the secrets that lie locked within this minute sphere, we would have achieved complete understanding of man, including the manner of his origin from subhuman ancestors and the nature of his destiny in an evolutionary future now unknown. Not in your time or mine, nor in the time of our sons and grandsons, will we succeed in doing this. But still the progress of modern science has been so great in this direction in recent years that it is now possible to redefine some of the most basic concepts of biology in terms enormously more meaningful than those used but a few years ago."

Chemical Advance Against Insects

From Agriculture Research, Feb. 1959

Researchers are showing gains in a quest for compounds to make better insecticides, attractants, and repellents.

► USDA SCIENTISTS are advancing against insect pests along three chemical fronts. Chemists and entomologists are developing more effective yet safer insecticides . . . attractants . . . repellents.

A promising new insecticide — less harmful to warm-blooded animals than any in use — is now in the final stages of development. Known as 6-chloropiperonyl chrysanthemumate, it is one of some 900 compounds synthesized in the past year at the ARS pesticide chemicals research laboratories at Beltsville, Md. The new insecticide is only one-eighth as toxic to animals as pyrethrum and one-third as toxic as allethrin. Pyrethrum, a natural product, and allethrin, a pyrethrum-like material developed by ARS chemists in 1949, have been the safest insecticides.

An effective attractant for the Mediterranean fruit fly is another new compound synthesized at the Beltsville laboratory. Following tests in Hawaii, the attractant replaced scarce angelica seed oil in the thousands of traps hung throughout Florida in the campaign to eradicate the fruit fly there. Traps baited with the attractant to lure Medflies enabled scouting crews to map infested areas, plan spraying operations, and check on progress of the eradication campaign. Attractants are specific for each insect, and the scientists are continuing their efforts to discover or synthesize

compounds for use against the gypsy moth, pink bollworm, and boll weevil, as well as other fruit-fly pests.

Diethyltoluamide is the chemical name of a superior all-purpose insect repellent, newest of a series of successful repellents developed by the ARS scientists. It was primarily developed to protect military personnel from malaria and other insect-borne diseases. The repellent is now commercially available (under different trade names) for the protection of picnickers, backyard gardeners, and all people who work or play outdoors.

Before a new compound is released for use against harmful insects, it undergoes extensive field tests by cooperating entomologists throughout the United States. The results are analyzed and evaluated.

The next step is to find out the proper dosage and method of application of a promising new chemical. Particle size and other physical properties are studied to develop the most effective forms and mixtures; physical and chemical characteristics relating to its use in aerosols are determined; problems of deterioration in storage of both chemical and container are solved.

If an insecticide is intended for use on fruit, vegetable, or forage crops, the residues on treated crops are painstakingly analyzed.

The strength and rate of applica-

tion
ticular
toler

Direct
think

A. C
tr

(
(

(
(

(
(

B. V
fr

(
(

(
(

(
(

C. T
c
r

F
t
e
f

(
(

(
(

(
(

(
(

(
(

► A
sear

cera

the

sup

T
sile

FEB

tion recommended for use on a particular crop must conform with safe tolerances set by law.

All this research is aimed at making our insecticidal chemicals deadly to the pest but safe to use.

✓ Chemistry Quiz ✓

Directions: Mark within the parentheses corresponding to the answer you think is *most nearly correct*. Answers are on page 18.

- | | |
|---|---|
| <p>A. Germanium is commercially extracted from
 <input type="checkbox"/> 1. carnotite
 <input type="checkbox"/> 2. coal ash
 <input type="checkbox"/> 3. residue from silver smelting
 <input type="checkbox"/> 4. sea water</p> <p>B. Which of the following is an <i>efflorescent</i> chemical?
 <input type="checkbox"/> 1. calcium chloride
 <input type="checkbox"/> 2. sodium carbonate
 <input type="checkbox"/> 3. sugar
 <input type="checkbox"/> 4. sulfuric acid</p> <p>C. There is evidence that when a nuclear particle of a certain type meets its opposite number, the proton, the resulting explosion turns the particles into "bursts of energy." The nuclear particle referred to is
 <input type="checkbox"/> 1. a meson</p> | <p><input type="checkbox"/> 2. a positron
 <input type="checkbox"/> 3. an anti-proton
 <input type="checkbox"/> 4. an electron</p> <p>D. The man who disproved the Phlogiston Theory was
 <input type="checkbox"/> 1. Avogadro
 <input type="checkbox"/> 2. Gay-Lussac
 <input type="checkbox"/> 3. Lavoisier
 <input type="checkbox"/> 4. Priestly</p> <p>E. Which of the following chemicals is a plant growth stimulant?
 <input type="checkbox"/> 1. adipic acid
 <input type="checkbox"/> 2. ethanol
 <input type="checkbox"/> 3. gibberellic acid
 <input type="checkbox"/> 4. glutamic acid</p> <p>F. Which of the following is <i>not</i> typically an aromatic substance?
 <input type="checkbox"/> 1. naphthalene
 <input type="checkbox"/> 2. phenol
 <input type="checkbox"/> 3. picric acid
 <input type="checkbox"/> 4. quinone</p> |
|---|---|

On the Back Cover

► A BOEING Airplane Company research engineer demonstrates a new ceramic material which can withstand the high temperatures associated with supersonic flight.

This material might be used in missile nose cones or for the leading wing

edges of high-speed aircraft. The material is capable of withstanding in excess of 4,000 degrees F. without melting. Note the low factor of heat conductivity which allows the engineer to hold the sample so close to the flame.

Chemical Specialties Manufacturers Association

► THE CHEMICAL Specialties Manufacturers Association, Inc. was founded in 1914 under the name of the Insecticide and Disinfectant Manufacturers Association. By 1949, however, the membership had expanded its products to such an extent in the chemical specialty field that the new name was adopted as more descriptive. The CSMA is composed of over 400 member companies who manufacture chemical products for household and industry. The products include such items as floor waxes, polishes, insecticides, moth proofers, disinfectants, sanitizers, automotive chemicals, soaps and detergent specialties, aerosols, cleansers, weed killers, bleach and many others.

One of the major problems facing the businessman today is the increased legislation and regulatory action being taken by the various local, state and federal governments. The CSMA subscribes to a special legislative reporting service which keeps in touch with all of the legislative branches whose actions might affect the membership. Further, the association prepares a compilation of all laws concerning the industry, which is given to members. This book is probably the most comprehensive of its kind published today.

Through committees and officers, the CSMA is constantly working to see that all specifications for public purchases are uniform. It develops specifications and testing methods for insect sprays and disinfectants, as well as other methods for testing floor wax-

es, brake fluids, and cleaning compounds.

The CSMA conducts annual surveys on a number of the products of the membership; it annually produces and distributes Official Test Insecticide, Official Test Aerosol, Tentative Official Test Linoleum, Tentative Official Test Asphalt Tile, Standardization Charts for Slip Testing Machines, and Standardized Metal Strips for Corrosion Testing.

The CSMA finances and supervises research fellowships at leading universities; it cooperates with government agencies for improvement of product quality and industry standards. The Association has advised, and will continue to advise legislative bodies on regulations covering the packaging and labeling of products produced by the membership. The CSMA, in conjunction with the U. S. Bureau of Standards and related industries, is constantly working on specifications and methods to protect its members.

There are six active Divisions of the Chemical Specialties Manufacturers Association:

- Aerosol
- Automotive
- Insecticide
- Disinfectant and Sanitizers
- Soap, Detergent and Sanitary Chemical Products
- Waxes and Floor Finishes

The Association meets twice annually, holding its regular annual meeting early in December. Its mid-

year meeting is held usually in May. Meetings are held in various cities throughout the country, average attendance approximating 1,000 representatives of member firms.

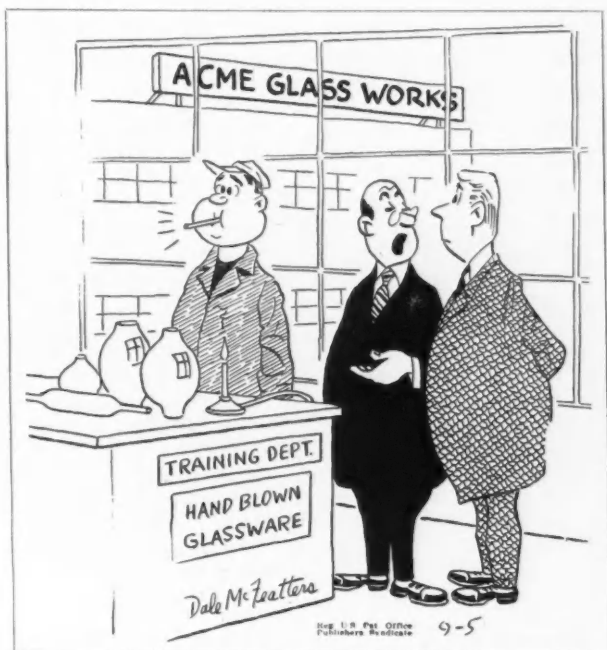
The Chemical Specialties Manufacturers Association is located in the Chemists' Club Building at 50 East 41st Street, New York City 17, New York.

Nickel Controls Leaf Rust

► INORGANIC NICKEL is coming to the aid of the wheat farmer. Field experiments indicate nickel salts, particularly chloride and nitrate, can control leaf rust of wheat, say F. R. Forsyth and B. Peturson of the Canadian Department of Agriculture's research

laboratory, Winnipeg.

Applications of the nickel compounds eradicated wheat leaf rust and caused increases in yield varying from eight percent to 21 percent, a scientific paper distributed by the U. S. Department of Agriculture states.



"He inhaled!"

Atomic Waste Problem

► AS THE NATION and the world develop a tremendous atomic-powered future, an equally large problem — the disposal of radioactive wastes — confronts planners.

The problem has had the attention of atomic energy specialists in past years and was taken up at open Congressional hearings by the Joint Committee on Atomic Energy (Jan. 28-Feb. 3).

If radioactive wastes were the kind that could be buried somewhere and forgotten, there would be little to worry about. But because of the nature of radioactivity there are ways for it to contaminate foods and pollute drinking water at great distances from dumping places.

Ordinary trash usually loses whatever toxic activity it contains in a fairly short time. Some atomic wastes may remain radioactive for a few hours or days. But others keep pouring out deadly radiations for as long as thousands of years.

The immediate and long-range effects of radiation on man are at best imperfectly understood. It is known that large doses of radiation can kill rapidly. This has happened to three atomic energy workers, none of them involved in waste disposal operations, since 1945. (Employees in the atomic energy industry are generally well-protected, their accident rate being below the national industrial average.)

Smaller chronic doses are believed to have deleterious effects but there is little specific information. In its 1958 report, the United Nations Sci-

entific Committee on the Effects of Chronic Radiation said long-term exposure to certain radiation levels could cause illnesses after latent periods. It may damage blood-forming tissues and bring on the development of leukemia and a type of anemia. It may also cause fibrotic and sclerotic changes in tissues, a diminished resistance to infection, a shortening of life span and malignant tumors. The U. N. report also pointed to genetic damage that may be carried from generation to generation.

Very small radiation doses are a subject of controversy, some scientists believing they do not cause biological and genetic damage and others arguing that no dose is too small not to have some effect.

How then is the potent disposal problem now being handled and what are the future prospects?

Dr. Joseph A. Lieberman, chief of the Environmental and Sanitary Engineering branch of the U. S. Atomic Energy Commission's Reactor Development Division, told Science Service that the management of radioactive wastes is primarily concerned with the protection of man and his environment.

The AEC uses a series of standards for maximum permissible concentrations with which to work in all its programs, including waste disposal. They were developed and recommended by the National Committee on Radiation Protection under the National Bureau of Standards' sponsorship. The standards are complex since each organ of the body has its

unique sensitivity to radiation, and each type of radiation has individual characteristics.

Actually, Dr. Lieberman said, there is more than a single problem. The wastes come in three forms — solid, liquid and gaseous. Some have high levels of radioactivity while others are relatively weak. Is it possible to dispose of them into the sea or the atmosphere, or to store them for long

periods of time? What are the geologic, oceanographic and meteorologic characteristics of the disposal and storage areas?

With these and other considerations in mind, Dr. Lieberman put the approaches to disposal into two rough categories. One is a technique for handling low level wastes containing quantities of radioactive materials as small as fractions of a millionth of a



➤ Two sailors and two health physicists from the Brookhaven National Laboratory, Upton, New York, stow low level radioactive wastes aboard a Navy LST for disposal at sea.

curie — a curie being the equivalent of one gram of radium. Dr. Lieberman called the technique the "dilute and disperse approach." Some low level wastes are dumped at sea to sink 1,000 fathoms or more in concrete-lined containers. Should the containers deteriorate, the wastes would be diluted to negligible levels in the water. At present, the AEC has designated ocean dumping areas 120 miles off the New Jersey coast and 60 miles out of San Francisco.

Gaseous wastes containing radioactive materials are routed through filter systems for removal of small particles and then passed out a high stack to be dispersed by the atmosphere. In order to insure safety, the atmosphere and environment are thoroughly investigated. For this, the AEC has enlisted the aid of the U. S. Weather Bureau, the U. S. Geological Survey, the U. S. Public Health Service and other specialized agencies.

What could go wrong with this kind of set-up is exemplified in the Windscale air-cooled reactor accident in England a year and a half ago which indirectly involved the waste control system. In a maintenance operation, the uranium fuel overheated and caught fire, sending fission products out the stack. Radioactivity spread over a wide area contaminating pastures and authorities were forced to condemn 250,000 gallons of milk. Newer reactors are not of the air-cooled type and have multiple controls that reduce the probability of such an accident recurring.

High level wastes, containing up to hundreds of curies per gallon, are handled through what Dr. Lieberman called the "concentrate and contain

approach." At present, these powerful waste products are kept at the AEC's Savannah River, Idaho and Hanford installations away from highly populated areas. Stored in specially designed underground steel tanks holding from 50,000 to 750,000 gallons, some wastes require cooling to prevent boiling due to the heat of radioactive decay.

Dr. Lieberman said there is little danger in these areas of radioactivity seeping into ground water and becoming a biological hazard. Should materials escape from the primary containers their radiations could be detected and the leaking tanks could be emptied. The ability of natural soils to absorb and hold certain radioactive isotopes might also be considered a safety factor.

Dr. Lieberman is skeptical about the disposal of high level wastes into the sea and he believes it never probably will be done. Not only do there appear better and cheaper ways, he said, but our knowledge of the sea environment, its mineral resources and its life is not complete.

Uncontrolled radioactive contamination could possibly render some of man's seafood and marine resources useless.

The disposal of radioactive wastes until now seems to have been well and safely handled. But how about the future with its expected large concentrations of nuclear reactors?

It is estimated that the U. S. in the last 14 years has accumulated 60,000,000 gallons of radioactive wastes in storage tanks. Some of the materials will remain dangerous for centuries, plutonium for at least 24,000 years. By the year 2000, the accumulated

high level liquid waste volume has been estimated to reach about 2,000,000,000 gallons.

Dr. Lieberman cited some research into the problem. Four possible future techniques for managing high level wastes are:

1. Conversion of liquid wastes into chemically inert solids. For example, montmorillonite clay absorbs some radioactive materials. The clay is heated to 800 degrees Centigrade causing a collapse of its lattice structure around the radioactive materials. Thus held fast in solid form the waste substances are impermeable to water and will not dissolve away. The solids may be stored in special locations indefinitely.

2. Direct disposal into geologic formations. Investigations are just beginning into the feasibility of using salt structures, impermeable shales and porous formations.

3. Disposal into deep wells and basins containing brines. Drilled for the purpose, the wells, according to preliminary reports, will have to be not less than 3,000 feet deep.

4. Specific removal of certain usable fission products. Long-lived radioactive products that might be useful in medicine and industry could be separated and removed from short-lived wastes. The removal would have to be enormously efficient if it were to serve a useful disposal purpose.

Dr. Lieberman believes that the word "radioactivity" still conjures up a picture to many people of a violent mushroom cloud. He hopes that they also view radioactivity as a means to peaceful power, bringing the promise of health and plenty to the people of the world. Despite the hazardous nature of radioactivity, it is up to man to overcome the problems and make full use of its promise.

Power Plant To Play Space Role

► THE ATOMIC Energy Commission's announcement of a "significant breakthrough" in producing electric power directly from heat brought quick reaction from the nation's biggest makers of electric power machines.

The consensus was that the five-pound thermoelectric generator, fueled with the radioisotope polonium-210, does not portend free electricity to be made in home basements.

A sizable atomic power station would be required to power the lights and appliances in a home, it was explained, and this would take much too big an investment for home owners.

Known as SNAP III — which

stands for System for Nuclear Auxiliary Power — the unit's vital statistics are these: nearly five inches in diameter, five and one-half inches tall, five watts initial output of power. In the course of 280 days — two half-lives of the polonium source — SNAP III could produce an estimated quantity of electricity equal to 1,450 pounds "of the best conventional batteries available," the White House said.

Developed in four months for AEC by The Martin Company of Baltimore, Md., in conjunction with the Minnesota Mining and Manufacturing Company of St. Paul, Minn., the little generator is expected to "open

the door" to unlimited practical usage of waste atomic products now lying idle in safe storage.

Its first applications are expected to be in U. S. satellites, to power radios and instruments. But improvements might suit it to air and sea navigation aids, or perhaps even telephone and telegraph lines.

The AEC said the first generator cost \$15,000, but this cost would drop

to \$200 on a production basis, exclusive of fuel. Polonium-210 is expensive, but the AEC officials said a much less costly atomic waste product could be used instead.

At its full charge of 3,000 curies, the unit produced five watts of power at eight percent to ten percent efficiency. But after polonium passed its half-life of 140 days, the power dropped to three watts.

"More" Uranium Than Ever

► AFTER MORE than a decade of heavy uranium mining, an Atomic Energy Commission expert says the U. S. is in even better shape than ever with respect to its stock of this critical radioactive material. Uranium is used to fuel nuclear reactors, make A-bombs, and trigger H-bombs.

Jesse C. Johnson, director of AEC's division of raw materials, told the National Western Mining Conference in Denver, Colorado, that continued long-range exploration and development programs should hold U. S. uranium ore reserves at a satisfactory level through 1966.

He said the 1958 ore reserve picture showed a substantial drop in prospecting and exploration. At mid-year, it appeared that newly devel-

oped ore would offset ore mined, and that the year would close with U. S. uranium reserves about where they were at the start of the year. But instead, preliminary figures now indicate that ore reserves increased about 4,000,000 tons after more than 5,000,000 tons were mined. So more than 9,000,000 tons were "developed," he said.

"The knowledge and experience gained in exploring for uranium, and the successful results achieved, indicate that the undiscovered uranium resources of this country are far greater than those already developed," he said.

So, as far as uranium is concerned, the U. S. seems to be in great shape.

Alloy Resists Heat

► A NEW METAL ALLOY that is tough, light and heat-resistant has been developed at Ohio State University. It is made up of three elements — niobium, zirconium and titanium. Their percentages by weight are 48, 49 and 3, respectively. The importance of the alloy is said to be its extreme strength while still being low in density and

resistant to oxidation at high temperatures. Several metals have two combinations of these three qualities, but none has all three, according to University engineers. The new alloy is effective at temperatures up to 2,000 degrees Fahrenheit, whereas stainless steel is effective up to about 1,500 degrees.

Chemical Kills Water Weeds

► A CHEMICAL for killing water weeds in irrigation canals, and also disease-carrying water snails breeding in canals, has been shown economically effective.

In the journal *Science* (Feb. 6), three scientists reported that submersed weeds have been controlled as far as 15 to 20 miles below the point of application, using only about one gallon of acrolein for each cubic foot of water flow per second during a period of between 30 and 45 minutes.

In less than one week after treatment, the water-carrying capacity of such a large canal, 60 feet wide, nearly doubled, and the beneficial effect lasted for as long as eight weeks before retreatment became necessary.

Drs. J. van Overbeek, W. J. Hughes and R. Blondeau of Shell Development Company's agricultural research division reported that acrolein has been found "highly effective" against

water snails in canals treated. Although these were not the same kind of snails that cause the schistosomiasis so prevalent in underdeveloped countries of the world, the scientists believe acrolein "promises to become a useful tool" in the battle to eradicate the *Schistosoma* blood flukes.

Acrolein is a potent irritant, and causes copious tears, but in the hands of a skilled operator with proper application equipment it can be applied safely and without irritation and discomfort.

In the western United States alone, farmers spend millions of dollars every year for control of weeds in canals. Mechanical methods of clearing channels, such as draining and drying, hand-cleaning, chaining and dredging, have proved relatively inefficient or cumbersome, time-consuming and expensive. Other chemical methods have also proved not totally effective.

Radiation Theory and Detection

► Two outstanding 16-year-old scientists have been looking into current problems of radioactivity from the very different angles of the protection of people from radioactive fallout and of the possibly good effects it may have after all.

Jonathan D. Leavitt of Easton, Pa., has come up with an idea for a small, economy-size radiation counter that will run on penlight batteries and could be produced for about \$20 and distributed to civil defense groups. This scintillation counter would be transistorized, to make it as compact

as possible, and simple enough to be used accurately by untrained people.

Jon has designed the counter specifically for use in indicating relative danger of incident radiation and checking food and water for contamination.

Approaching the subject from a long-range historical viewpoint, Joseph P. Vajk of Princeton Junction, N. J., theorizes that radioactivity actually may be useful in speeding up evolution of the human species and making man more deserving of the

"wise" part of his "homo sapiens" label.

Joseph has found that certain periods in evolution show outbursts or "explosions" of new groups, indicating an increased mutation rate. Since increased background radioactivity causes more mutations, Joseph explains periods of rapid evolution by means of radioactivity and periods of intensive mountain-building and volcanic activity.

In the long run, says Joseph, an increase in radiation would result in a superior species, possibly with increased brain capacity, although such

progress would be at the cost of harm to millions of individuals. The ethical problem presented here is, of course, a serious one and beyond the scope of his present discussion, the young scientist states.

Research papers presenting the scintillation counter design and the theory of explosive evolution contributed to Jon's and Joseph's being named among the top 40 winners of the 18th Science Talent Search for Westinghouse Science Scholarships and Awards, conducted by Science Clubs of America as an activity of Science Service.

Plastics Combine Metals

► PLASTICS may be used to unite previously incompatible elements, opening new vistas of industrial applications for reinforced plastics.

John Delmonte, general manager of Furane Plastics, Inc., Los Angeles, told the Society of the Plastics Industry, Inc., meeting in Chicago that certain combinations of metallic elements previously considered metallurgically impossible may now be accomplished in a matrix of epoxy resin.

Such metals, he said, would join with the plastic to form a "filled" system, not a true alloy.

Mr. Delmonte mentioned graphite, lead, copper, zinc and tin alloys as materials that can be united in num-

erous combinations in a matrix of plastic. Metals used can be chosen for properties wanted, such as surface friction, density, and specific heat.

A possible use for a plastic-metal combination, he said, would be in radiation shieldings for nuclear reactors.

A good shielding must absorb thermal neutrons and gamma radiation. As an available, low-cost element, lead fulfills the need for gamma radiation.

Using powdered lead in an epoxy matrix proves to be more efficient than using lead slabs, because reactor shielding has to be easily shaped or poured on the spot.

Polymerization is the uniting of two or more similar molecules into another compound having the same elements in the same proportions, but a higher molecular weight and different physical properties.

Bacteria are found in most soluble oil emulsions and synthetic cutting fluids used in industry and are believed to be the cause of foul odors and staining of metals, and may even be the cause of a dermatitis.

Book Condensations

ELEMENTARY PRACTICAL ORGANIC CHEMISTRY: Small Scale Preparations, Qualitative Organic Analysis, Quantitative Organic Analysis — Arthur I. Vogel — *Longmans*, 890 p., illus., \$9.75. Complete textbook of elementary practical organic chemistry.

BASIC ORGANIC CHEMISTRY — Louis F. Fieser and Mary Fieser — *Heath*, 369 p., illus., \$6. Organic chemistry textbook adaptable to a short course.

PROCESSING OF THERMOPLASTIC MATERIALS — Ernest C. Bernhardt, Ed. — *Reinhold*, 690 p., illus., \$18. Reviews the engineering fundamentals on which the design of plastics processing equipment is based.

GAS CHROMATOGRAPHY 1958 — D. H. Desty, Ed. — *Academic*, 383 p., illus., \$13. Proceedings of the second symposium organized by the Gas Chromatography Discussion Group held at the Royal Tropical Institute, Amsterdam, May 1958.

STERIC EFFECTS IN CONJUGATED SYSTEMS — G. W. Gray, Ed. — *Academic*, 181 p., \$6.50. Proceedings of a Symposium held at The University, Hull, July 1958, by The Chemical Society.

CHEMISTRY PROBLEMS AND HOW TO SOLVE THEM — Paul R. Frey — *Barnes & Noble*, 5th ed., 228 p., paper, \$1.50. 180 completely solved examples, 874 problems with answers.

THE THEORY OF THE PROPERTIES OF METALS AND ALLOYS — N. F. Mott and H. Jones — *Dover*, 326 p., paper, \$1.85. Reprint of 1936 British edition.

ADVANCES IN CARBOHYDRATE CHEMISTRY Vol. 13 — Melville L. Wol-

from and R. Stuart Tipson, Eds. — *Academic*, 387 p., \$11. Contains chapters on the methyl ethers of the monosaccharides, the chemical nature of the sialic acids and the development of starch nitrate as an explosive.

SCALE-UP IN PRACTICE — Richard Fleming, Ed. — *Reinhold*, 134 p., \$4.50. Based on an "Experience in Industry", symposium jointly sponsored by Philadelphia-Wilmington Section of the American Institute of Chemical Engineers and the University of Pennsylvania.

SYNTHETIC METHODS OF ORGANIC CHEMISTRY: Yearbook Vol. 12 — W. Theilheimer — *Interscience*, 546 p., \$22.50. Reports on new trends in the synthesis of organic compounds and improvements of known methods published between 1955 and 1957. Includes German Register-Schlüssel of volumes 1-12.

A TEXTBOOK OF ORGANIC CHEMISTRY: Historical, Structural & Economic — John Read and F. D. Gunstone — *Bell, G.*, 4th rev. ed., 610 p., illus., \$5.25. Includes discussions of modern theories of organic chemical structure, reactivity and reaction mechanism.

THE CHEMICAL ELEMENTS — Philip S. Chen — *Chemical Elements Co.* (South Lancaster, Mass.), rev. ed., chart 36 x 48 inches, \$1. Gives all data on the elements, their derivation, discovery, isotopes, occurrence, preparation, uses, production and distribution.

LAMINATED PLASTICS: Including High-Pressure and Low-Pressure Types and Reinforced Plastics — D.

J. Duffin with Charles Nerzig — *Reinhold*, 254 p., illus., \$5.75. Survey of the manufacturing, fabrication, and application of high- and low-pressure laminates.

ON THE STRENGTH OF CLASSICAL FIBRES AND FIBRE BUNDLES — B. D. Coleman — *Mellon Institute*, 11 p., paper, free upon request direct to publisher, 4400-5th Ave., Pittsburgh 13, Pa.

AN INTRODUCTION TO ELECTRONIC THEORIES OF ORGANIC CHEMISTRY —

G. I. Brown — *Longmans*, 209 p., illus., \$3. Introduction to the theories which can be understood by any student with knowledge of the simpler facts of organic chemistry.

THE PROPERTIES AND STRUCTURE OF MATTER: Part 1 — Lewis Pokras — *Macmillan*, 580 p., illus., paper, \$5. Experimental college textbook of fundamental chemistry with stress on more independent study by the student.

SCIENCE SERVICE AIDS TO DISCOVER AND DEVELOP SCIENCE ABILITY

THE CHEMICAL ELEMENTS

Their properties, sources, most important isotopes, characteristic compounds, places in the periodic table and histories of their discoveries, including announcements. Up-to-date, revision includes element 102. Fully indexed, paper bound. Invaluable for reference. By Helen M. Davis with revisions by Dr. Glenn T. Seaborg. Postpaid 10 copies for \$5.00.

Each 55¢

LAWS OF MATTER UP-TO-DATE

A new edition of the list of fundamental laws of physics which have been changed as the result of new discoveries of the atomic age. Postpaid 100 copies for \$3.00.

Each 10¢

ORGANIC CHEMISTRY FOR THE HOME LAB

Learn to think chemically . . . Mauve, the first aniline dye, was discovered one hundred years ago by a young chemist who followed where his curiosity led him. You can make this and other beautiful dyes, interesting plastics, fundamental chemicals, by following these clear directions . . . a handy book, written by Burton L. Hawk.

Postpaid \$2.00

SCIENTIFIC INSTRUMENTS YOU CAN MAKE

How teen-age scientists have designed and built astronomical instruments, spectroscopes, Tesla coils, oscilloscopes, cloud chambers, atom counters, Van de Graaff generators, electronic computers, stroboscopes, and demonstrated ultrasonics, chromatography, photomicrography and mathematical constructions. Illustrations show the completed instruments. References guide the reader to research in the fields opened by use of these instruments.

Postpaid \$2.00

SCIENCE EXHIBITS

Science Exhibits tells you how to select your material, how to plan its presentation, how to display, to label and to light it, how to describe the work you have done.

Postpaid \$2.00

EXPERIMENTING WITH CHEMISTRY

For those who wish to start experiments in chemistry, this is a guide and laboratory manual which includes detailed explanations of reactions and processes for advanced students. More than 125 experiments. By Burton L. Hawk.

Postpaid \$2.00

Order from SCIENCE SERVICE, 1719 N St. N.W., Washington 6, D. C.

Chemistry and Dental Science

"Dental Projects for High School Science Students," has been produced for the American Dental Association by Science Service. This new booklet contains ideas and informative experiments in oral chemistry and related subjects.

A chapter on Oral Biochemistry has five experiments to introduce you to the huge area of interest available to a biochemist investigating the largely unexplored area of the oral cavity. Other chapters contain items on oral bacteria, amylase activity, and acid production.

The booklet is designed for the science student, science teacher, or club sponsor. Although all who do the experiments may not aspire to become dental practitioners or dental scientists, the basic methods suggested are applicable to all fields of science.

— Use this convenient coupon to order your copies now. —

SCIENCE SERVICE, 1719 N St., N.W., Washington 6, D. C.

Send me _____ copies of "Dental Projects for High School Science Students" as checked below (single copy price — 25¢):

() 10 copies - \$2.00

() 20 copies - \$4.00

() 30 copies - \$6.00

\$ _____ enclosed

Name _____

Address _____

City, Zone, State _____

CHEM-2-59

